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January 2021

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Successful Farming magazine serves the diverse business, production, and family information needs of families who make farming and ranching their business. Our passion is to help you make money, save time, and grow your satisfaction in the farming business.

ACROSS THE
EDITOR'S DESK®

SUCCESS IN 2021

Read our two reports on potential moneymakers for farmers and ranchers.

Here at *Successful Farming*® magazine, we are “dedicated to making farmers successful.” That’s our mission. Success is part of our name.

We take it seriously, whether it is on these pages, our website, our TV show, radio programs, or podcasts. (By the way, did you get a smart speaker for a holiday gift? Access the smart codes below to use our Alexa skill or Google Home to get live commodities prices.)

Trouble is, the **definition of success** changes every season, depending on seed selection, inputs, soil conditions, commodities markets, and the weather. Helping you to make more money is central to our editorial coverage. In this issue, we find two avenues for you to save or even make money in farming and ranching:

In **“The Solar Power Bonanza”** (pages 44-47), Executive Editor for Machinery Dave Mowitz explores the innovation and technology that allows farmers to use solar power as their operation’s primary energy source – and sell the excess back to utilities. Mowitz does a great service to educate us on the potential payback that solar power can have today and for years to come.

In **“Pay Dirt”** (pages 28-34), Gil Gullickson, the executive editor for crops technology, details the world of carbon sequestration. A solution to our world’s problems with greenhouse gases could be right under our feet – in the soil and in the practices by crops and livestock producers to capture more carbon.

It’s not the first rodeo for carbon markets or solar energy, but we hope these reports help you **succeed** in growing your operation.

Here’s to a successful 2021! 



Dave Kurns

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Soil Health Podcasts

The Journey From Dirt to Soil

Gabe Brown struggled with Mother Nature. After 10 years of wet springs, dry summers, hailstorms, and bills to pay, Brown decided there had to be a better way. This is the story of his journey to soil health, and the book he wrote to help others.

The Gateway to Cover Crops

Steve Groff is a pioneer in the cover crop movement. He was a driving force in the widespread adoption of radishes as a major component of cover crop blends around the world.

Soil Health With Zero Tillage

In the 1970s, no-till farming was about as rare as a day with no wind on the prairies of North Dakota and Manitoba, Canada, but farmers in the two nations came together to jointly work for a common goal.

On the Front Lines

Doug Peterson, an NRCS regional soil health specialist, is passionate about helping farmers solve resource concerns with their soils, whether it's weeds, insects, or erosion. Peterson encourages implementing the right soil health principles for every farmer's situation.

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CHARLES BARON

Baron cofounded Farmers Business Network in 2014.

By **Natalina Sents**
Digital Content Manager
Natalina.Sents@meredith.com | @Roots_Journey

Charles Baron has made disruption his profession. As cofounder of Farmers Business Network (FBN), he has changed the way some farmers do business – allowing them to connect with each other while they research and buy farm inputs anywhere they have internet.

It's all about e-commerce, he says, which gives network members transparency, efficiency, fair pricing, and an overall better customer experience. "You don't have to go negotiate in an office with somebody," he says. "A customer once told me, 'I spent \$20,000 while in my underwear.' That's great."

SF: How do you explain FBN's unique business model?

CB: We're a network of growers. We have a big community, over 21,000 farmers who are wanting to change the industry, to change the basic framework and the rules of the game they have to operate in. They work together and with FBN to do that.

It's a way of growers connecting with each other online with information and commerce to get more power, to level the playing field, and to get better information and an edge in the market. It's a membership network; we just use technology to do it.

SF: What does accountability look like?

CB: We're young. We've got a bit of a track record now, but we don't have the luxury of a brand that has been around 100 years and everyone recognizes and puts under the Christmas tree. We have to earn it every day. We're 100% accountable to every interaction we have with our customers. We have to fight for and earn every inch we get.

SF: Tell me about someone who's been influential in your ag career.

CB: I had not stepped foot on a farm until I was 23 and I met my future brother-in-law, Anthony, and became fascinated by his life in Nebraska.

I grew up in California. I went to school in New England. I'd not spent time on a farm, or a lot of time in the Midwest. I had no appreciation for agriculture or rural business and how hard it is.

Anthony and I are the same age, but I felt like he was light-years ahead of me in terms of sophistication and what he was having to deal with and manage. I realized how hard the job is, how many things a farmer has to do. You

have to be a mechanic. You have to be an agronomist. You have to be a chemical expert, a marketer, a businessperson, an accountant. You've got to do everything. It's very, very complicated.

I realized something else as I was riding around with him in the grain cart listening to the markets update. The radio announcer is saying there's rain in Brazil, so beans are down. I said, what does Brazil have to do with Nebraska? It was just amazing that you're in this globally connected system that is driving your livelihood in rural America, yet you're totally on your own.

And finally, when we created FBN, I always had a basic test. If I was going to create a business in agriculture that was going to be opposed to a customer's interest, then I wouldn't survive Christmas with my brother-in-law. He played lineman for Nebraska.

SF: Is this what you pictured when you started FBN?

CB: It's never, never easy. But it's gone incredibly well. It is so rewarding to see thousands of members out here and to be

delivering value and saving them money or making them money. We're actually changing the industry. That's the best thing you could possibly hope for. We've only just started. We're in the bottom of the first inning.

SF: What keeps you up at night?

CB: The long-term position of farmers. Most producers raise commodities, which are a global business. It's hard to get an edge in commodities. What are you going to do when commodity demand dips, or trade pops up, or suppliers consolidate? Those all put pressure on producers if you're tied to the commodity system.

I think producers should do a couple things. Number one, if you're growing commodities, manage your costs ruthlessly. Get into the strongest financial position you possibly can so you're equipped. Number two, develop options. Create competition so this market doesn't get consolidated. That's fundamental. Number three, look for alternatives. That's organic, non-GMO, specialty crops, premium crops, regenerative premiums – anything you can do to sell direct. **SF**

SF Bio

Name: Charles Baron

Background: Baron previously worked for Google in advanced technologies.

Education: Baron has a bachelor's degree from Dartmouth and an MBA from Harvard. He's also completed coursework at MIT.



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Compiled by
By **Megan Schilling**
Agronomy &
Technology Editor

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CARLA SCHULTZ

This farmer runs on synergy and sustainability.

By **Megan Schilling**
Agronomy & Technology Editor
megan.schilling@meredith.com | [@meganjoyv](https://twitter.com/meganjoyv)

SF: How do you raise your livestock and crops sustainably?

CS: One of my favorite words is *synergy*. And that goes hand in hand with sustainability because sustainability to us means taking all of the individual pieces and ensuring they work well individually but, more importantly, together.

We realize there is a strong micro-organism community below the ground so most of our fields are no-till. We also implement cover crops. My husband always says, “Mother Nature never wants to be naked.” With our cattle, we practice rotational grazing. For us, that works really well. It’s a whole system where the manure that goes back into the soil feeds the microbes and the cattle then get high-quality forage all summer.

SF: What has been a success for you on the farm?

CS: This question harkens back to family and our kids having a turn on the farm. Each of them has different strengths, and it’s so cool to see them involved on the farm. It teaches them accountability, especially with the animals. They have more responsibility because there is something living and breathing that needs to be tended.

The second success is the launching of Eight Plates Farm, which has been a fun

adventure and has provided such meaningful connections. Sometimes you don’t realize, as a farmer, that people are looking for information and products. We’ve seen that with our online presence.

SF: What do you think is one of the biggest challenges in agriculture today?

CS: I think the reality that we can’t do everything, but we need to be more open and engage in conversation with each other. We can’t be against each other as farmers – we need to be on the same team.

For example, I will have some customers who want 100% grass-fed beef but for our operation, we are 95% grass and 5% grain because we want the marbling in the beef. I’m happy to send those customers to another farmer who can provide 100% grass-fed because that works for his farm. It doesn’t mean either of us is raising our cattle wrong. One size does not fit all.

SF: What is the best advice you’ve received?

CS: As you get older, you realize the importance of listening before you speak, and I mean really listening – not having your mind made up already with how you’re going to reply. Another one of my favorite sayings is, “When you fall, pick something up.” We’re all going to fall. But take a little piece of what went wrong and keep it with you. It will help you be better for the next time you fall. Years go by, and those little pieces add up to wisdom. **SF**

Carla Schultz farms just two hours north of Detroit – in the thumb of Michigan – with her husband, Paul; their four children; and Carla’s parents.

Together, they make up Eight Plates Farm, so named to indicate everyone has a place at the table.

“We want to encourage connections and to start a conversation,” Schultz says. “The name brings to mind thoughts of family, good times together at the dinner table, and the reality that it all started with a farmer growing the food.”

Schultz believes that table extends even beyond the home. With a strong social media presence and as a regular at markets in the suburbs of Detroit, she is able to connect with diverse audiences. “I love to listen to customers’ cultures, what they eat, and make the connection between food, home, and memories. It’s how I learn, too.”

Eight Plates Farm is also diverse. The Schultzes raise corn, soybeans, wheat, edible beans, cattle, hogs, and chickens.



Background: Carla Schultz farms with her husband, Paul; their children, Silas, Eve, Phoebe, and Piper; and Carla’s parents, Mitchell and Krystal LaBair. Eight Plates Farm is on Facebook and Instagram, where Schultz shares photos and videos to educate

Mayville, MI
Founded in 1865.
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her followers about agriculture. “Everyone can’t come to the farm. Through social media, I can give people a glimpse of what we’re doing every day. I tend to be very real about life on the farm and show more than a romanticized version of agriculture.”



“Everything is at stake when *grassland* is converted.”

Grasslands purify water, mitigate flooding, and create habitat for birds and wildlife, p. 36.

“A customer once told me, ‘I spent \$20,000 while in my underwear.’ *That’s great.*”

Farmers are growing more comfortable with ecommerce, p. 4.

“WE HAVE CREATED A ROBOT THAT WILL FUNDAMENTALLY CHANGE HOW GRAIN BINS ARE MANAGED.”

The 26-pound Grain Weevil moves across the top of grain to break up crusts, level bins, and do inspections, p. 40.

Nebraskans say their two solar arrays “offset

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of our farm’s total energy draw.”

Solar incentives can drop installation cost to 7¢ per kwh, p. 44.

“Studies show *[sulfur]* applications spike soybean yields

10 to 15 bushels per acre.”

Results depend on soil type, amount of organic matter, and timing, p. 48.

“Respect isn’t lost by getting knocked down – it’s earned by **how well you can get back up again.**”

Small failures in farm management lead to big wins, p. 17.



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ROUND TWO

Will farmers join
climate fight this time?



A decade ago, farmers adamantly opposed the Obama administration's cap-and-trade plan despite Agriculture Secretary Tom Vilsack's promise of income from carbon sequestration contracts. Vilsack will try again to persuade U.S. agriculture to mitigate climate change, this time as USDA chief for President Biden, who wants the United States to be the first country to achieve net-zero greenhouse gas emissions from farming.

Vilsack welcomed the "incredible opportunity" to put agriculture in the global forefront in combatting climate change — for years a forbidden topic in farm country — "and reaping the new, good-paying jobs that will come from that leadership." Biden says his climate plan will create new sources of farm income, "by paying farmers to put their land in conservation and plant cover crops that use the soil to capture carbon." There are many paths the new administration could take.

One would create a carbon bank to USDA, using the broad powers of the same agency that financed Trump-era trade war and pandemic relief payments, to finance large-scale investments in "climate-smart land management practices" and using other USDA tools, such as crop

insurance and conservation programs to encourage climate mitigation. Backers of that approach include Robert Bonnie, former agriculture undersecretary for natural resources, who led a USDA review team for Biden. In a white paper, Bonnie and other climate experts recommended the administration emphasize collaboration and incentives in dealing with farmers and forestry owners.

The newly formed Food and Agriculture Climate Alliance says a USDA carbon bank could set floor prices for carbon capture. The alliance, composed of farm, environmental, and food-retailer groups, also says climate mitigation in the agriculture sector should be built on voluntary action and market-driven opportunities such as carbon trading.

Collin Peterson, the former House Agriculture chairman, says the easiest way to achieve climate goals would be to double the CRP to a minimum of 50 million acres. "It's the No. 1 thing we can do in agriculture." Farmers were fiercely skeptical of cap-and-trade in 2009, and there is a lot of skepticism about carbon trading today, he says.

After serving throughout the Obama years, Vilsack was an unexpected repeat

choice for agriculture secretary. “He wasn’t looking for this job. But I was persistent,” said Biden.

In Case You Missed It

MACROECONOMY

Economic Recovery May Bolster Farm Income

A resurgent U.S. economy will grow by 4% this year, its fastest rate in two decades, as the world recovers from the coronavirus pandemic, according to an early projection by USDA. Interest and inflation rates would remain low, aiding economic expansion. Economic growth could support commodity prices and reduce the expected drop in net farm income (a USDA gauge of profitability) from 2020, the highest in seven years and fueled by record-high federal payments.

“One thing is certain, net farm income [profitability] in 2021 will be lower,” says Farm Bureau economist John Newton, perhaps \$90 billion to \$100 billion, assuming the fall rally in commodity prices continues and farm payments return to normal levels. “If China follows through on its purchases, I think we could certainly see higher [cash] receipts for 2021,” says former USDA chief economist Joe Glauber. In that case, income could run at pre-trade-war levels.

INTERNATIONAL TRADE

USDA Forecasts Record Exports to China

Ending the estrangement of the trade war, China will buy a record \$27 billion of U.S. farm exports this year and regain its ranking as the top foreign market for American ag products, says the USDA. Big sales to China would be part of a 12% surge in U.S. exports, to a near-record \$152 billion, from last year’s \$135.9 billion, fueled by rising corn and soybean prices and strong demand from China. Prospects for the coronavirus vaccine are “adding to hopes that GDP growth may return strong in 2021,” says USDA.

FARM SUPPORTS

Family Farms Are Exempt From Manager Rule

The USDA says its new rule that limits farms to a maximum of four managers who can collect crop subsidies does not apply to family farms. That’s the opposite of what it said in an August 24 regulation. The USDA issued a “correction,” limiting the rule to “farming operations comprised of non-family members,” such as general partnerships or joint ventures, following complaints that the regulation would have adverse effects on family-run farms.

TRADE DISPUTES

Canada Is Target of USMCA Challenge by U.S.

The Trump administration filed the first enforcement action under the U.S.-Mexico-Canada Agreement over a familiar issue – access to Canada’s dairy market. U.S. Trade Representative Robert Lighthizer said Canada was manipulating tariff-rate quotas to limit duty-free entry of U.S. products. If consultations are fruitless, the next step would be appointment of a panel to examine the issue. **SF**

Upcoming

January

• **18-21:** National

Biodiesel

Conference

February

• **2:** Farm Credit

Council annual
meeting

• **5:** USDA estimates
2021 farm income

• **16-18:** National

Ethanol

Conference

• **18-19:** USDA
annual

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• **4-6:** Commodity
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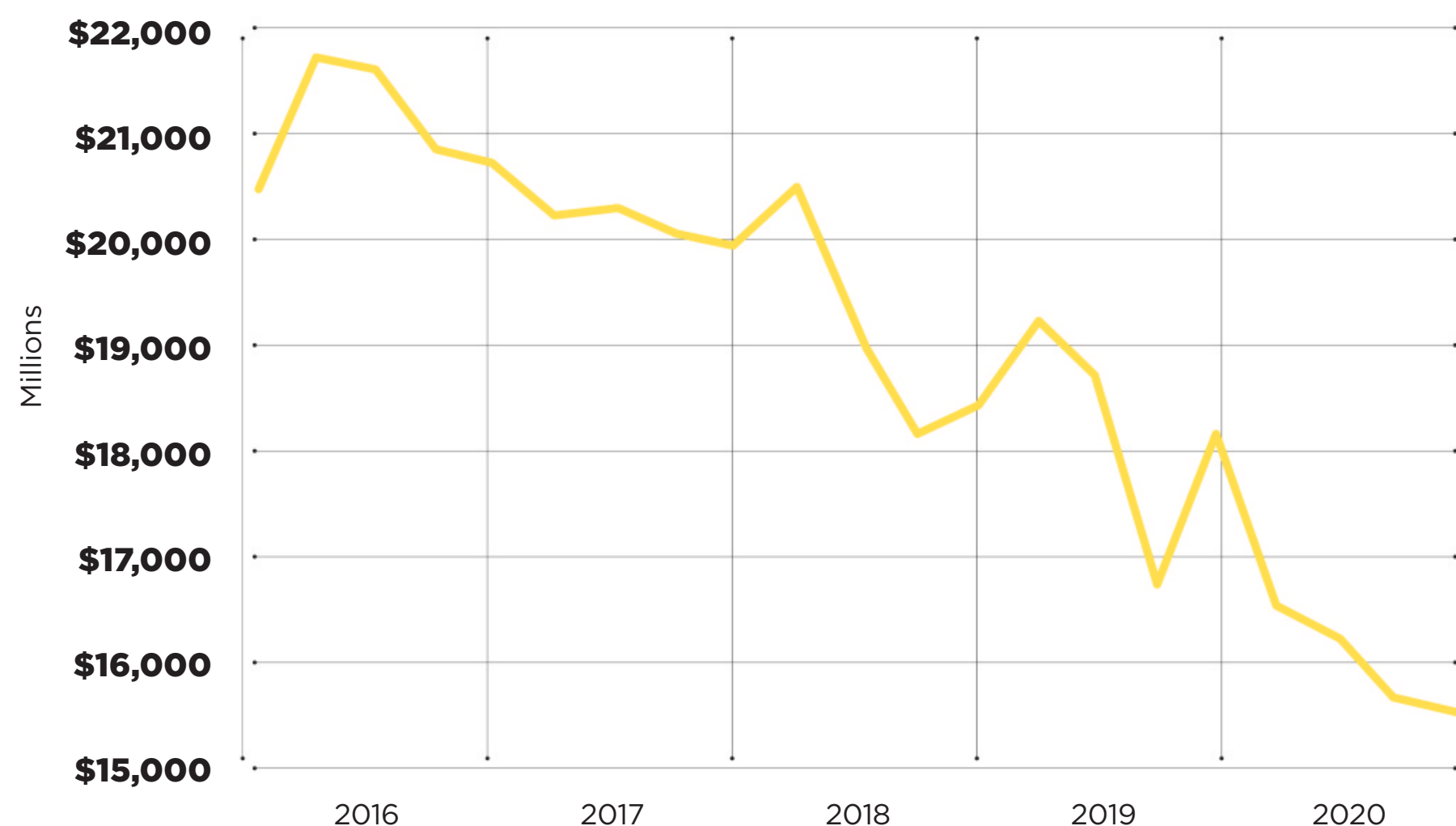
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Top 100 Banks Ranked by Assets



AG LENDERS GIVE HOPE TO FARMERS

There's good news in the ag lending business. Interest rates remain low, while delinquencies and defaults hold steady.

By Shawn Williamson

As leaders in the agricultural lending sector size up what happened in 2020, it's also time to look ahead at the coming year.

Did agricultural loan balances increase on average in 2020? Were interest rates up or down? Were loan payments timely? Were defaults up? How does 2021 look on the interest rate front?

The lending industry offers answers to these questions. Tim Koch, the executive vice president and chief credit officer for Farm Credit Services of America (FCSAmerica) and Frontier Farm Credit, says ag loans overall went up in 2020 but not in all categories.

At the end of 2020, FCSAmerica was holding approximately \$32 billion in ag loans, up about 7%, after starting the year close to \$30 billion. Line of credit balances decreased during 2020, while real estate loans increased.

Land acquisitions accounted for about 25% of new loans, and refinancing accounted for roughly 75%, according to Koch. This could indicate that many farmers were working on reducing their variable short-term interest rates on credit lines and locking in lower long-term fixed rates.

Koch noted that interest rates dropped significantly during March and April 2020. Ten-year Treasury yields bottomed August 4 at .52% and have been rising gradually since, nearing .9% as of the end of November.

Farm loan delinquencies and defaults both held steady in 2020 compared with 2018 and 2019, Koch says. In addition, Koch says, "We don't anticipate a significant jump in interest rates during 2021," which will benefit farmers.

Similar assessments are offered by Shawn Smeins, head of Rabo AgriFinance, part of Rabobank, the Dutch multinational bank and one of the biggest holders of ag loans in

the United States.

In aggregate, the borrowers that Rabo works with didn't see a significant rise in loan balances in 2020. "In the Midwest, government payments, such as ARC, Cares Act, and PPP loans, helped farmers a lot on the cash flow front," Smeins says.

Overall, ag lenders such as Farm Credit Services and Rabo AgriFinance dealt with more farm real estate loans than operating loans during 2020.

Smeins also verified that defaults at Rabo AgriFinance were stable during 2020, around the same levels as 2018 and 2019. "We had very few requests for deferrals," Smeins says. That's good news for farmers preparing to get financial support for the 2021 growing season.

Regarding ag loan interest rates, Rabo AgriFinance bases its rates on LIBOR, and the 30-day LIBOR has been pretty steady, according to Smeins.

"Interest rates continue to be historically low for well-performing operators and real estate loans," Smeins says. "Producers should consider locking into long-term rates. They are running as low as 3.5% for some tenures in excess of 15 years on good-quality land in many areas across the country."

2021 Outlook

Looking ahead, ag lenders say they are finding more ways to work with farmers as technology and the



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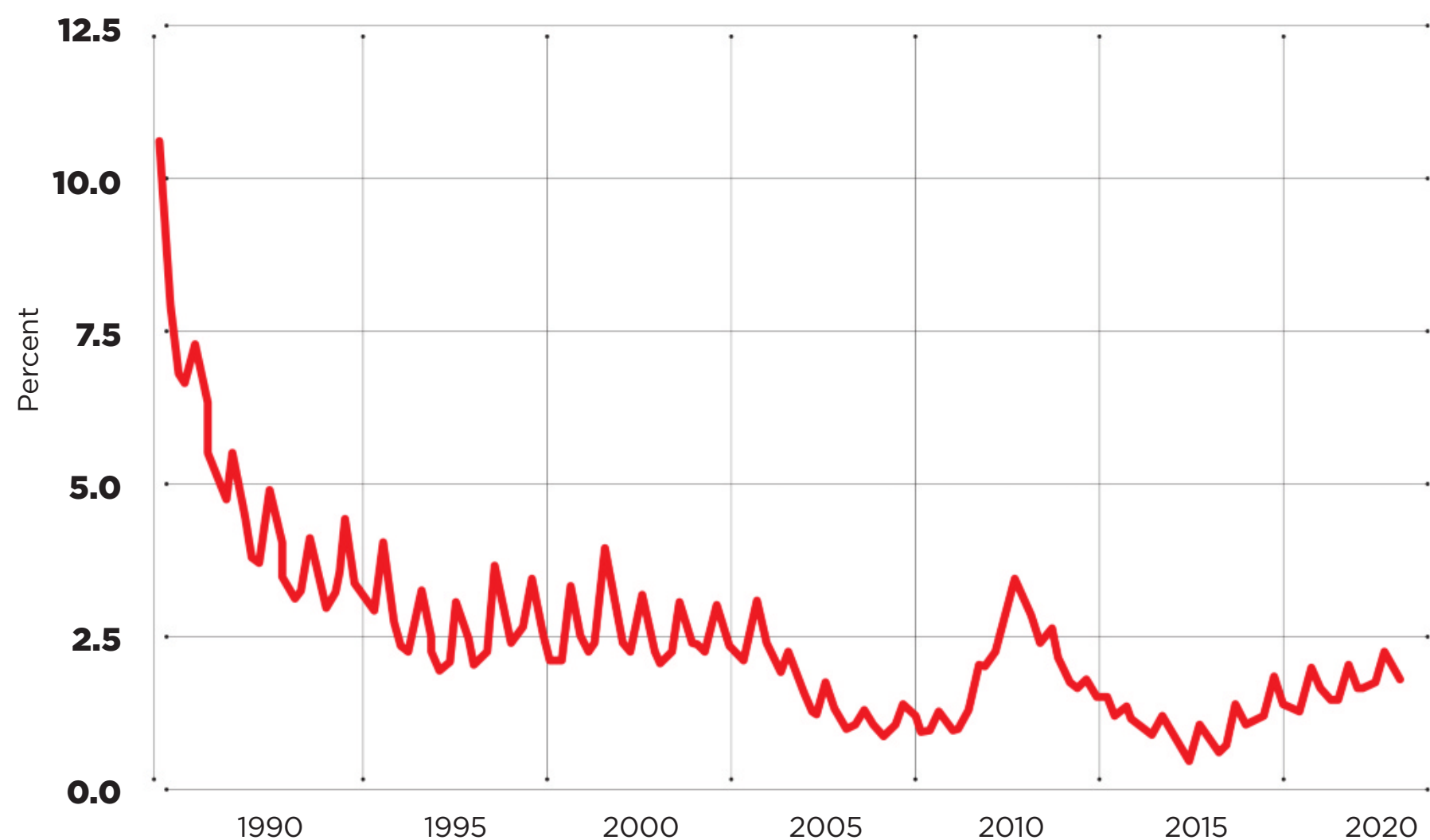
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DELINQUENCY RATE ON AGRICULTURE PRODUCTION

All Commercial Banks



coronavirus pandemic have altered the way farmers and commercial businesses operate.

Much like other agribusinesses, FCSAmerica reports banks are communicating with customers on Zoom and other online platforms.

In addition, FCSAmerica has recently launched an online real estate loan application.

Farmers should monitor how technology is changing their business, according to Smeins. “Tech is changing every day. Farmers are going to have to embrace technology,” Smeins says.

Rabo AgriFinance does not foresee farm profitability being significantly different in 2021. “Tight breakevens are likely still in play,” Smeins says.

He adds that he does not expect much change in interest rates in 2021, but it will be determined by the next administration.

The banking industry survives on an interest spread (basically the difference between interest income and interest expense). It will be interesting to see if five-year CD rates come back up to 3% in the next 10 years, while some banks are still receiving 3% in loan interest.

PPP Tax Picture

Ag lenders saw little 2020 activity in the Paycheck Protection Program (PPP) administered by the Small Business Administration, according to Koch. FCSAmerica lent \$100 million in PPP loans out of about \$3 billion in new loans.

This low-interest loan category was offered during the coronavirus pandemic to keep workers on the payroll in small businesses, including farm operations.

Under the program, big banks, community lenders, and financial tech firms approved 5.2 million government-backed loans to small businesses hurt by pandemic lockdowns. If farmers and other borrowers spend the money on payroll and other business expenses, the government repays the lender.

“At the end of November, we had submitted about 25% of our PPP forgiveness applications, and about half of those had been processed by the SBA,” Koch says.

My accounting clients received millions of dollars in PPP loans. Some ultimately needed it to survive, while others ended up not needing it much at all. But in March and April, the duration and severity of

the economic shutdown were unknown. Even solid companies were cutting costs and raising cash, in case a V-shape recovery did not materialize.

For some restaurants and entertainment companies, 2020 put them out of business or into hibernation. However, some companies found a way to operate and fought their way back to normal profit levels. Others even had record years.

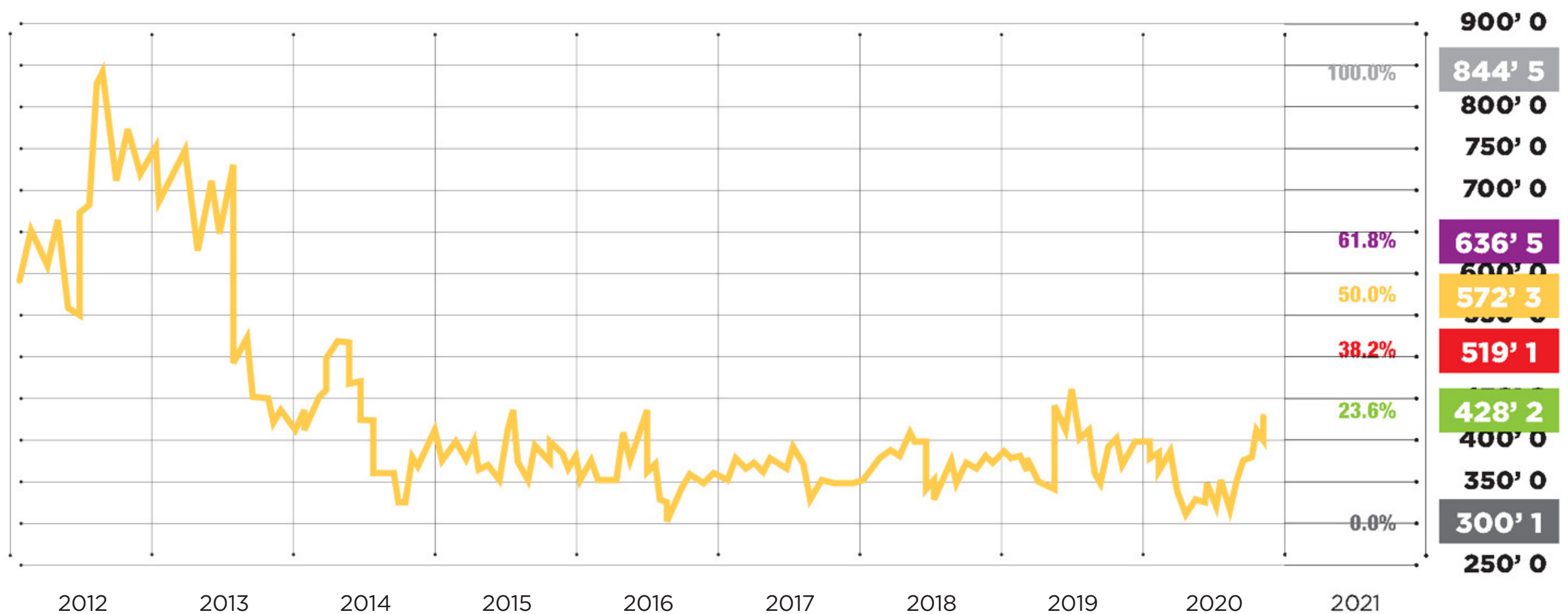
On the loan forgiveness front, 90% of PPP loan balances for my clients were still sitting on balance sheets at the end of November. In most cases, the forgiveness applications had not been prepared or had not been submitted by the lender. As of the end of November, I had seen only a few SBA forgiveness approvals.

The IRS released guidance in November about handling taxes regarding PPP forgivable loans that were pending approval at the end of 2020.

If the expectation is that full forgiveness will be granted for the use of loan proceeds, then the farmers and business owners will not take a deduction for the wages, rents, or utilities paid with the PPP money.

In effect, the business will pay tax on the proceeds on the 2020 tax return, regardless of whether the PPP debt is forgiven in 2020 or 2021. If the forgiveness application is denied or the farmer does not even apply for forgiveness, the deductions stay in place on the 2020 return. **SF**

MONTHLY CORN WITH FIBONACCI RETRACEMENTS



NEW YEAR, NEW GOALS

Grain market and profit outlook turn higher.

By Al Kluis

In April, I received an email from a longtime customer who is a really good farmer who gets great yields, uses all the new technology tools he can, and works hard at marketing. He is usually an optimist; however, this was his question: “Is it even worth planting corn this spring?”

The outlook and uncertainty from April through August 2020 were as bad and as negative as I have lived through in the past 20 years. The farmers who were able to move through it all – and stay profitable – focused on cutting costs, maximizing yields, and using a full set of marketing tools. As a chartist, I had a lot of indicators that prices would bottom again in August or September 2020. Indeed, in 2020 the lows came in early August, but it was amazing how fast and how far this rally has taken prices and profits.

Here are the key factors that caused this huge counter-seasonal rally.

- **Strong demand**
- **Lower acres**
- **Lower-than-expected yields**
- **Global end-user buying**

Let's look at these factors in more detail.

1. Strong demand. China was actively buying U.S. corn and soybean meal in 2020. In 2019, exports to China were hit with a double whammy. First, exports were down because of the U.S.-China trade war. Then Chinese demand was hit hard when the country lost about 35% of its hog herd to African swine fever.

What a difference a year makes. The Chinese have been aggressively increasing hog production, increasing their sow herd by more than 30% in the past year – an estimated 78 million more hogs. (Compare this to the total U.S. hog herd: about 76 million hogs.)

Recently, hog prices have been trending lower as supplies increase. However, Chinese hog farmers are still reporting over \$100-per-head profit. Plus all those extra hogs take a lot more corn and soybean meal!

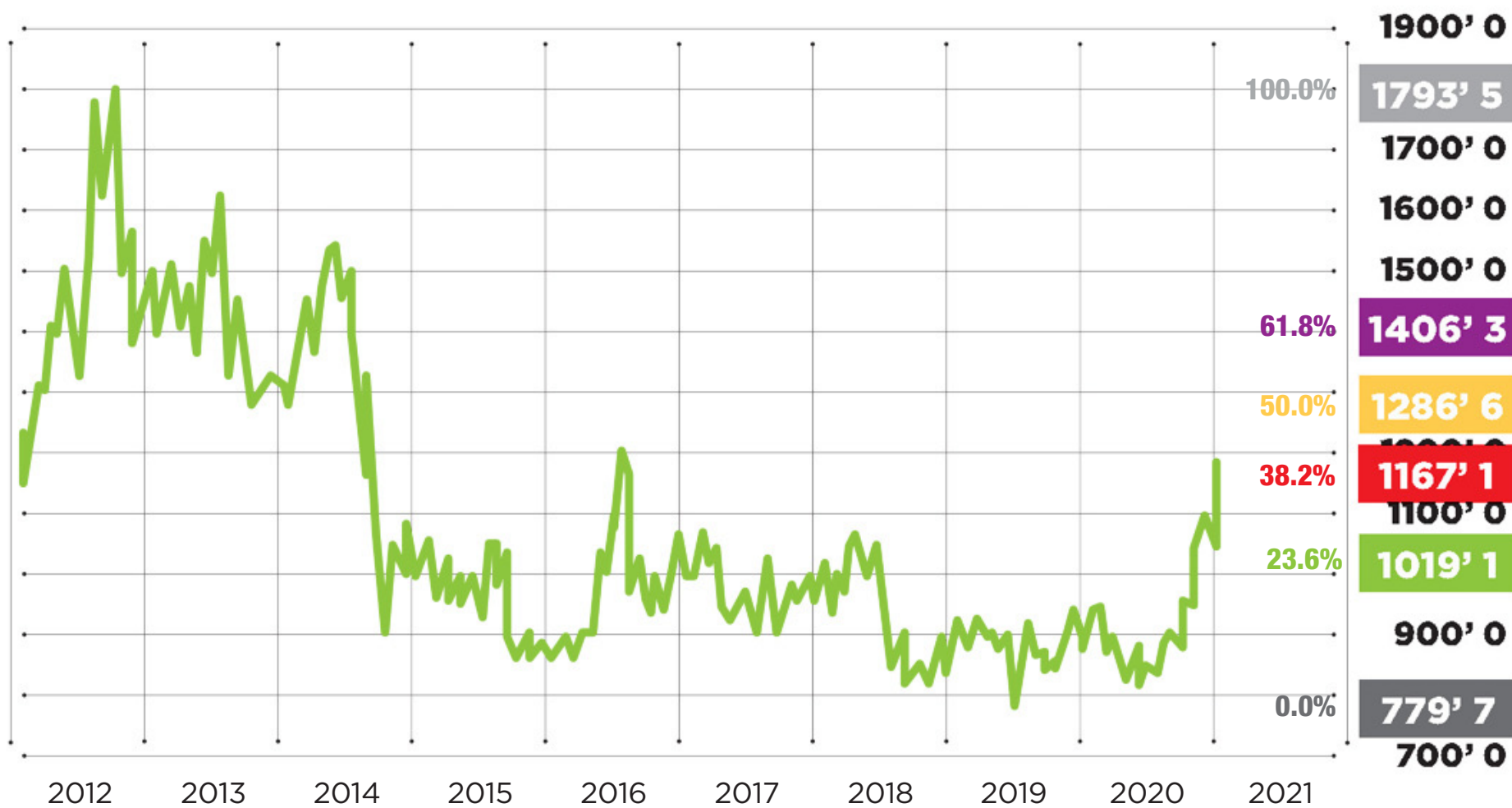
2. Lower acres. The USDA reported total U.S. corn and soybean acreage at 174 million acres, about 3 million acres less than expected. This drop was due to more prevented plant acres in the Dakotas. Then the derecho blew across the Corn Belt and hit Iowa very hard. The August windstorm lowered

This CBOT monthly corn continuation chart shows the monthly high, low, and close of nearby corn futures back to 2012. You can see the major high in 2012 at \$8.44 per bushel and then the drop to the double-bottom at \$3.00 in 2016 and 2020. After this extended eight-year bear market, I am watching for a 38%, 50%, or 61.8% retracement. I am also watching previous-year highs and the month the high came in. My first objective was at \$4.28; I now have price targets at \$5.19, \$5.72, and \$6.36.

yields for (and in some cases wiped out) the corn and soybean crops on as much as 14 million acres of prime farmland. Odds are good that harvested acres will move lower in the USDA final crop production report on January 12.

3. Lower-than-expected yields. U.S. corn and soybean crop ratings moved lower each week in August as dry conditions expanded across much of the western Corn Belt. The USDA took both corn and soybean

MONTHLY SOYBEANS WITH FIBONACCI RETRACEMENTS



This CBOT monthly soybean continuation chart shows the high, low, and close of nearby soybean futures back to 2012. You can see the major monthly high in 2012 at \$17.94 per bushel. From that high prices went down by just over \$10 per bushel to the low at \$7.80 in May 2019. The rally in late 2020 boosted futures above resistance at the May 2018 high at \$10.70. Now I am watching the 2016 high at \$12.08. The 50% retracement is at \$12.86, and then the 62% retracement is at \$14.06.

yields lower from October into November. The U.S. corn yield was reduced by 2.6 bushels per acre, and the soybean yield was reduced by 1.2 bushels per acre. Yields likely will move lower again in the USDA final crop production report.

4. Global end-user buying. Early this year, many world importers were waiting for a large U.S. crop with the plan to fill up at harvest. The wait for the harvest lows had worked great the past four years. When the markets took off so fast and so far in early August, many had no coverage. Panic mentality set in: They needed to get it bought before they ran out. This effect showed up in the weekly and monthly export sales report.

Two big questions now are: How high will the rally go? How long will it last? How high is a tough question. Since August, the grain market has moved higher and faster than I had imagined when I wrote more than a year ago to expect an election-year rally. To try to answer the question, let's pull out the long-term monthly corn and soybean charts.

For corn, let's use monthly retracements of the \$8.44 high in 2012 to the \$3.00 low in 2020. My initial objective was at \$4.28. Next, I look at the 2014 high (\$5.19). A 50% retracement of the 2012 high to the 2019 low projects prices up to \$5.72.

What about soybeans? The soybean chart shows the major high in late 2012 (\$17.94), then the drop to the low in May 2019 (\$7.80). The first major hurdle was getting above

the 2018 high (\$10.70). The next objective after that is the 2016 high (\$12.08). The 50% retracement is at \$12.87.

Please note that these are not price forecasts. These targets are calculated using mechanical methods. Using charts in this way is more effective than watching the market, and it lets us take the emotion out of making decisions.

Now let's look at how long the rally may last. That is another tough question. This time, I will pull out my weekly corn and soybean continuation charts. The major low that I use when studying the timing of the market is the last major low, from early August 2020. The pattern that I have observed in the grain markets in the past decade is a pattern of nine to 10 months low to low. This pattern has been as little as six months and as long as 13 months. The grain markets will often rally for four to six months and then turn lower for three to five months. This January, the grain market rally will be a five-month-old rally. I am on guard for a high between January and March.

I will update my charts and provide my analysis of the USDA final crop production report on January 15 in a video. To view this video, go to [kluiscommodities.com/kca-tv-room](https://www.kluiscommodities.com/kca-tv-room). 

Note: The risk of loss in trading futures and/or options is substantial, and each investor

and/or trader must consider whether this is a suitable investment. Past performance – whether actual or indicated by simulated historical tests of strategies – is not indicative of future results. Trading advice reflects good-faith judgment at a specific time and is subject to change without notice. There is no guarantee that the advice given will result in profitable trades. •

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UNDERSTANDING THE DIFFERENCES IN HORSEPOWER

There is a world of difference among horsepower ratings, which can cause confusion when replacing engines and motors.

By Ray Bohacz

Engineers like to say that if the results do not match the math, then go back and check the math, because the sum cannot be less or more than the total of the parts. This brings us to the subject of horsepower and all the different types found on the farm.

There is engine, PTO, drawbar, electric, hydraulic, and wheel horsepower. It is important to understand how horsepower is determined for each power source. For example, you may have a 5-hp. gas engine you want to replace with an electric motor. What would be the gas engine horsepower equivalent in watts?

Mechanical Horsepower

When it comes to internal combustion engines (of any fuel), the horsepower it generates is based on the amount of work it does over a period of time. The faster the engine can perform the same amount of work (load), the more horsepower it has.

Horsepower in an internal combustion engine is calculated from its torque production working against a load that

is called a brake (either water-based or electrical) via an eddy current. Though we refer to horsepower, the true metric of an engine's power is its torque.

Mechanical horsepower (determined on a dynamometer) is determined by multiplying torque by engine rpm and then dividing that sum by 5,252. Though this equation stays the same, there are different test protocols that control the inlet air, coolant, and water temperatures; barometric pressure; humidity; rate of acceleration; and how quickly the load is applied to the engine.

In North America, engines are rated using the Society of Automotive Engineers (SAE) standard. Yet, there are multiple SAE standards. The difference among standards is found in the barometric air pressure, humidity, and ambient temperature values. These are called correction factors. So when considering an internal combustion engine, it's important to determine which standard and correction factors were used to rate it.

As air temperature is changed, horsepower is altered by about 1% for every 10°F. In simplest terms, engines

consuming cooler air can produce more power.

For example, Engine Company A may use an ambient air temperature of 50°F. in rating its engine, which results in 400 hp. But Engine Company B could employ a standard of 90°F. resulting in an advertised engine output of 390 hp.

If you didn't know the ambient air standard used when rating these engines, you'd assume that Company A's engine is more powerful than Company B's. But Company A's engine would produce 384 hp. if tested under the same standard as Company B's engine.

With the international presence of agriculture, you may see engines rated with correction factors and test protocols. Instead of SAE, the standards are from JIS (Japan) or DIN (Germany), or they are metric.

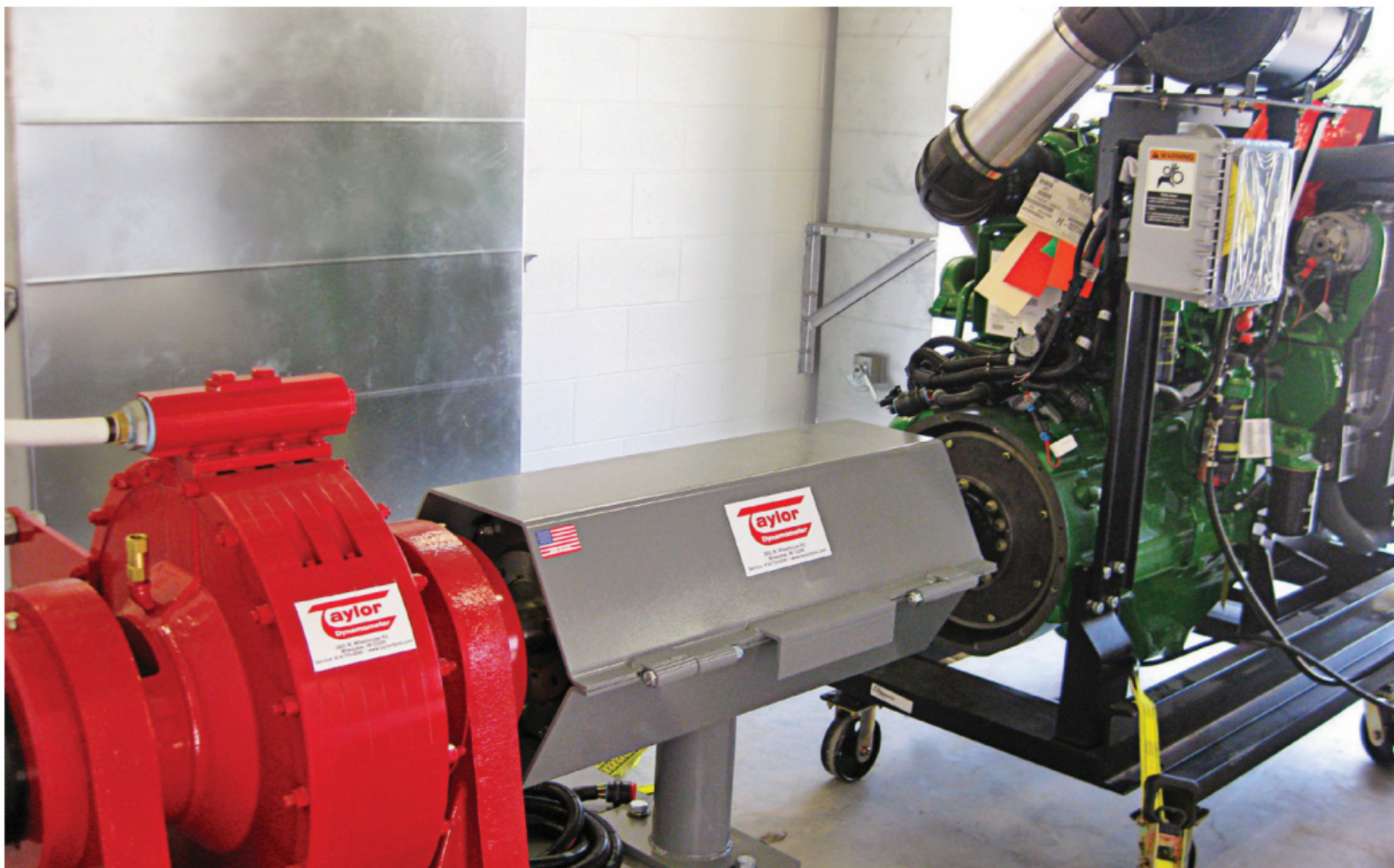
There are also engines that rate mechanical horsepower in kilowatts (1,000 watts). To convert kilowatts (kW) to SAE horsepower (hp.), you multiply an engine's horsepower by 1.34. For example, $500 \text{ kW} \times 1.34 = 670 \text{ SAE hp.}$

To convert from SAE hp. to kW, you multiply by 0.746. For example, $670 \text{ SAE hp. equals } 499.82 \text{ kW.}$

Gross and Net Horsepower

Gross and net horsepower are measured at the crankshaft and determine the way the engine is configured. Up until 1971, auto and truck engines were rated using the gross scale. That is the

Continue to next page



total amount of horsepower generated by an engine without losses caused by an air filter, exhaust system, accessories, cooler inlet air, or a higher barometric pressure with lower humidity. Net horsepower ratings factor in all installed components in an engine as well as ambient air temperature, humidity, and barometric pressure.

If you bought a pickup with an engine rated in 1970 using the gross standard, you would have found the exact same engine appeared to have less power when rated under the net rating in 1971.

PTO, Wheel Horsepower

Unlike mechanical horsepower, which is tested at the engine's crankshaft, PTO and wheel horsepower are measured at their respective location. Either of these ratings will be lower than mechanical horsepower since a portion of the horsepower at the crankshaft is consumed by the components it passes through resulting in a parasitic loss. The general rule is that there is about a 20% loss of horsepower from the crankshaft to the PTO or drive wheel. For example, 500 crankshaft hp. $\times 0.80 = 400$ PTO hp.

When working backward from the PTO or wheel horsepower to the crankshaft, there is a 25% gain. For example, 400 PTO hp. $\times 1.25$ equals 500 crankshaft hp.

Drawbar horsepower is a measurement

of a tractor's ability to pull an implement determined by pulling a weighted load that is fitted with a strain gauge to determine pull. Maximum ground speed is also measured. In many ways, drawbar horsepower is a true measure of the power the tractor can use to pull the implement. It is not only a function of engine power and drivetrain loss, but also the machine's ability to transfer the load to the tire.

Hydraulic Motor Horsepower

Hydraulic horsepower is calculated on hydraulic pressure in pounds per square inch (psi) multiplied by gallons per minute (gpm) in American measurement units with a multiplicative constant of 0.0005834. The formula to determine hydraulic motor horsepower is $\text{psi} \times \text{gpm} \times 0.0005834$. Thus, a hydraulic motor that turns out 400 psi at a flow of 100 gpm would turn out $23\frac{1}{3}$ hp.

Also, a hydraulic motor is sensitive to its displacement and the pressure-flow relationship that it receives. If you ever need to replace a hydraulic motor, check all the specifications against the original and the fluid circuit output of the host machine.

Electric Motor Horsepower

To determine the horsepower of an electric motor, you need to know the voltage

input, current draw in amps, and the rated efficiency of the motor. Also remember that 746 watts equals 1 hp. The input voltage and current draw in amps is from Ohm's Law, which states that $\text{volts} \times \text{amps} = \text{watts}$.

To calculate the horsepower of an electric motor, use this formula: $\text{volts} \times \text{amps} \times \text{rated efficiency} \div 746 \text{ watts}$.

Let's take, as an example, an electric motor rated at 480 volts, 50 amps that has a 92% rated efficiency. Thus, the horsepower of this motor is $480 \text{ volts} \times 50 \text{ amps} \times \text{a } 92\% \text{ rated efficiency} \div 746$, which $= 29.59 \text{ hp}$.

Now, some electric motors such as those used on shop air compressors will have their power stated as peak horsepower. This represents the power the motor has just as it starts, which sometimes can be five to seven times the rated continuous horsepower. This bump in horsepower is caused by the motor's start windings being engaged.

It's also important to know that an electric motor has full torque output at 0 rpm. This compares with an internal combustion engine that requires a certain operating speed to achieve peak torque.

Be mindful of the efficiency rating of replacement electric motors. One that has a higher rating will be more powerful, run cooler, and cost less to operate than a less-efficient motor. **SF**



LEADERSHIP TRANSFER FOR 2021

Problem: How do you set farm heirs up to lead if they lack respect from the team?

By **Mark McLaughlin**

Our son came back to farm several years ago, and we couldn't be happier. He's young and has a lot to learn, but he works hard and has good instincts. My goal for 2021 is to start transitioning more leadership over to him. I typically run our morning meetings with our crew, but after watching him lead several meetings, I feel some employees (who've been here longer than he has) do not respect him because of his experience level. He stuck with it though, despite getting knocked around with last year's challenges. How can we set him up to win this year as we transfer leadership?

- Submitted by email from D.M.

Solution:

Respect is a tricky thing. It can be slow to earn and quick to lose. Respect is ultimately about humble confidence; both within himself and mutually between the team. Confidence grows through experience, clarity of purpose, effective communication, and solid planning. Let's look at some ways to help him build on that this year.

• **Win the morning meetings.** Good coaches do pregame and postgame analysis. Do the same for your morning meetings. Review with him what went well, what didn't, and prepare for next time. Also, avoid being "the answer guy" during the meetings. That

steals respect from him. You've modeled how to lead. Have you modeled how to follow? He can ask you for advice before or after the meeting, but not during. Otherwise, their respect skips over him and goes back to you. It may be helpful for the team to observe you seeking his guidance occasionally.

• **Design the game plan.** How will he know if he's advancing in the farm transition? Try to identify the major roles of your business (e.g., marketing, selecting and purchasing inputs, finances, employee management, etc.). Then identify who currently manages each role. Next, prioritize the sequence of roles your son should start taking over, the associated time frame, and how to equip him to succeed in that position. This creates a measurable growth track, and growth builds confidence. Without a structured plan, every day just feels like a game of whack-a-mole.

• **Build the winning team.** Is the lack of respect something your son can overcome? Or is it something systemic within the team? Personalities mesh differently. The combination of team members who worked for you might not work for him. Maybe the team, or their roles, must be changed to be successful.

• **Fail small, win big.** Mark

Twain said, "Good decisions come from experience. Experience comes from making bad decisions." Let him fail sometimes so he stays humble and learns the bigger lesson of how to get back up when you're not around. Respect isn't lost by getting knocked down – it's earned by how well you can get back up again.

• Win the end game.

Sometimes the star player gets pulled out of the game at the most critical point. Will your backup be ready? If you were incapacitated or passed away, your son would have to win on three different fronts: managing the daily farm decisions, navigating the family dynamics, and leading his business team while missing his parent/partner. Be sure to get the estate and farm succession plan locked down. It will build his long-term confidence and show the faith you have in his farming future.

Experience is important, but it's not the only factor in gaining respect. Everyone got knocked around in 2020, regardless of experience level. We respect those who maintain integrity in the moment of their decisions. That takes confidence, humility, and faith. Maybe we all need that to win in 2021. **SF**



Mark McLaughlin is an associate with Farm Financial Strategies in Ankeny, Iowa. For the past 14 years, he has helped farm families across the Midwest develop their farm succession strategies. He grew up on a family farm near Defiance, Iowa, and shares in the fifth generation of ownership. He and his wife have three children. farmestate.com



DRY CROP SEASON IN SOUTH AMERICA TO CONTINUE

Very dry planting conditions across Brazil and Argentina in October and November are likely to extend through the growing season.

By Bill Kirk

Strong La Niñas are not typically a farmer's best friend both in the United States and in Brazil and Argentina.

The general world circulation pattern associated with a strong La Niña event creates subsidence, or sinking air, over North and South America for a warm and dry pattern, while rising air in the Southwest Pacific and Southeast Asia areas creates very wet conditions.

This cycle is expected to be the dominant concern through the entire 2021 growing season both in the United States and across South America.

We have already seen dry to drought-like conditions in just 8% of the United States in 2019 (in a weak El Niño-like pattern) grow to cover 65% of the country in 2020 with similar conditions materializing across Brazil and Argentina during the spring (September to November) 2020 planting season. The dry spring trends were very impressive in both the corn and soybean growing regions of Brazil and Argentina, with major soybean growing areas like Paraña in southern Brazil experiencing the driest season in 17 years and northeast Argentina the driest in 13 years and the second driest in more than 35 years.

Brazil's full-season corn crop had a bit better planting conditions, especially in the major growing area of Minas Gerais, which accounts for 22% of Brazil's total full-season



corn production, but 19% of full-season corn comes from the harder hit, much drier Paraña. Very dry soil conditions persisted for weeks after planting, so clearly there is much higher risk to yields when harvesting starts in the March-June time frame.

Relief for Soybean Areas

As the growing season progresses in 2021, conditions are more likely to improve a bit for harder hit soybean growing areas of Argentina (west of Buenos Aires) and southern Brazil (Paraña, Rio Grande do Sul) with more rainfall, even if the precipitation trends are still a bit below average.

The dry conditions are likely to expand through the Southern Hemisphere summer (December to March) in central Brazil's corn- and soybean-growing regions to include Minas Gerais, Mato Grosso, and Goiás that represent nearly 60% of Brazil's soybean production and 40% of full-season corn. This will become even more concerning for Brazil's second, or safrinha, corn crop in which more than 65% is grown in areas expected to be very dry during the second planting in March to June. Get ready for the CME to sound like concerned meteorologists!

As harvest for Brazil's first-season full crop starts in March, a lot of attention will be on how much weather reduced yields.

A strong La Niña, among other climate cycles, is having a big impact on South American crops through dry planting conditions, delayed planting, and very likely lower yields, a harbinger of things to come in the United States this spring.

The weather scenario is somewhat similar to the 2015-2016 season, when CONAB, Brazil's equivalent of USDA, lowered expected yields by 20% from pre-season expectations as the season progressed. Month after month the numbers came in lower and lower. In 2016 the weather and yield concerns across South America combined with a very dry start to the U.S. season to spur a commodity rally; that setup is likely to repeat as U.S. farmers plant in dry to very dry soils in 2021.

Weather Trends expects more than 60% of the United States to be in dry to drought-like phases by May, making it the driest planting season in eight years, similar to 2002, 2012, and 2013—years that ultimately resulted in below-trend-line yields. What we see happening in Brazil is very likely a harbinger of things to come in the United States. Unlike Brazil, the United States will very likely have another hyperactive hurricane season in 2021 with more crop risks to the Southeast.

Look out, Florida! **SF**

Learn More

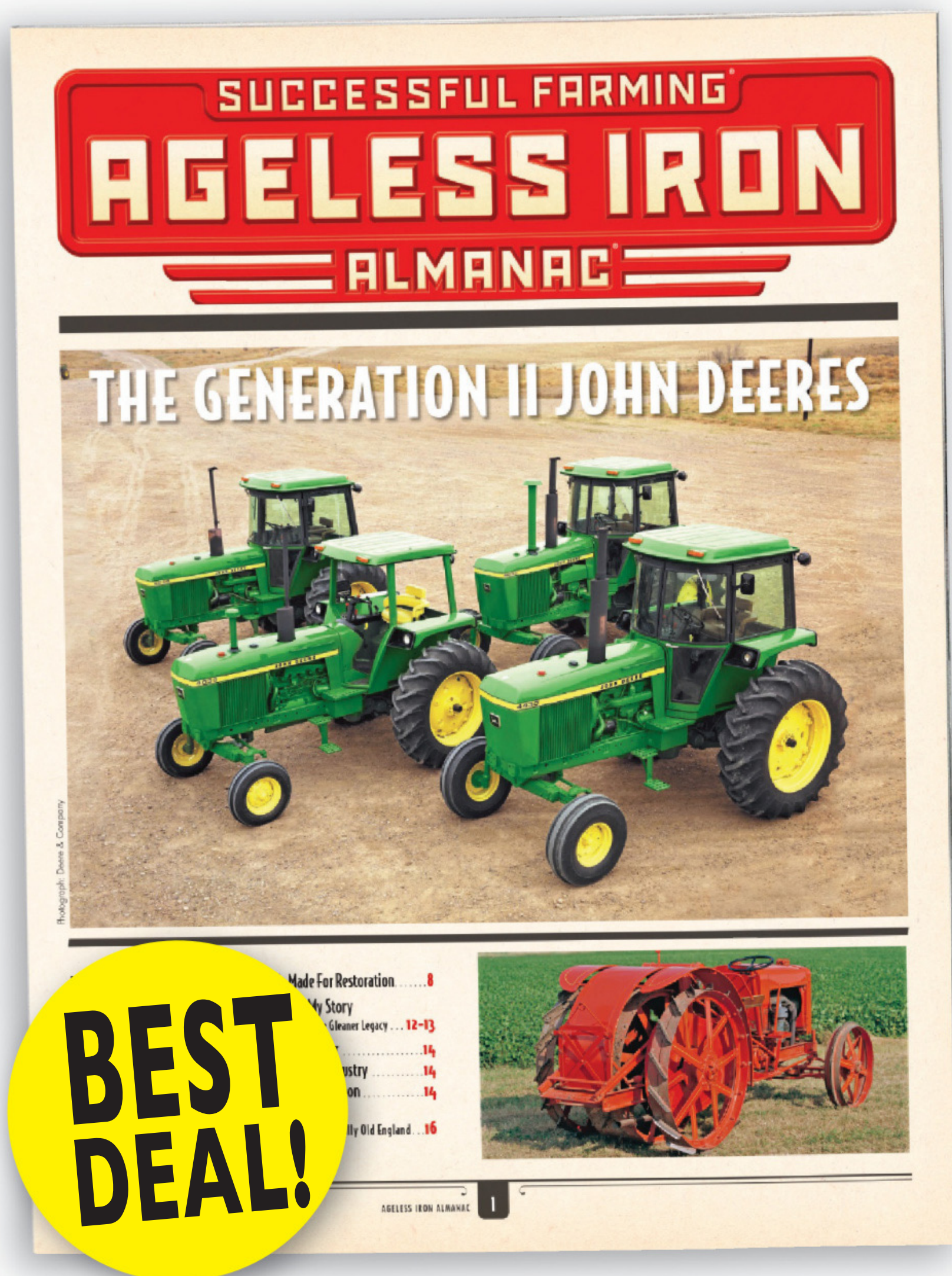
Bill Kirk is CEO of Weather Trends. A FarmCast subscription for Weathertrends360 forecasts looking out up to 365 days can be found at **wt360.com/ag** for \$399 a year.



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LIMITED AVAILABILITY OF PLANTERS

Supply of used implements reflects slow sales of new since 2014.

By **Dave Mowitz**
Executive Editor, Machinery & Technology
Dave.Mowitz@meredith.com

In the previous issue I took an in-depth look at late-model planter tractor price trends. So it's appropriate to follow up with an analysis of late-model planters.

The differences between the two are stark. While high-horsepower, front-wheel drive tractors are in good supply, late-model

planter availability is tighter than a drum.

Deere's used equipment site, machinefinder.com, lists 1,347 total planters available at press time. Narrow that search to 1775NTs (Deere's most popular planter in production since 2014) of any age, and that figure plummets to 275. By comparison there are more 8370R tractors (369) alone sitting on dealers' lots, not to mention all the other 8000 series models!

All late-model used equipment, except for tractors and combines, is in tight supply due to lack of new equipment sales since 2014.

Put tillage equipment into the getting-hard-to-find category, as well. It's a curious trend: Farmers usually invest in lower price items like planters and tillage equipment during tight times, opting to pass on upgrading tractors or combines. So you would expect more implements to be available now.

Contrary to the Past

That the tight supply of late-model planters is pouring a solid bottom on their values is a given in a used machinery marketplace that is beginning to boom (see "Machinery Insider," December 2020 issue).

This situation begs you to do some aggressive comparison shopping between a used planter

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based on actual dealer sales, auction purchases, and wholesale transactions on selected equipment built in the past 20 years. Used by banks, equipment manufacturers, and equipment dealers all over North America, the Iron Solutions equipment appraisal data are now available to you! •

JANUARY AUCTIONS

Jan. 9: A farm equipment liquidation auction is being held in Bishopville, South Carolina, by **Rebel Auction** (rebelauction.net).

9: **Tugwell Auction** (tugwellauctionrealty.com) will conduct a farm equipment sale in Littleton, North Carolina.

9: Farm, ranch, and construction equipment will be available at a **Live Oak Realty & Auction** (liveoak-auction.com) sale in Goldthwaite, Texas.

11: **Cook Auction** (cookauctionco.com) will hold a consignment sale in Clinton, Missouri.

16: Farm and dairy equipment will be featured in a sale being conducted by **Martin's Auction Service** (info@martinsauctionservice.com) in Clearspring, Maryland.

20: A construction equipment sale is being held by **Martin's Auction Service** (info@martinsauctionservice.com) in Shippensburg, Pennsylvania. •



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and a new machine. Bear in mind the investment you are going to have to make in replacement parts on older planters. Even basic items (bowls, belts, blades, brushes, and so on) can set you back \$12,000 to \$24,000 on a 24-row unit, for example.

The Pocket Price Guide (on the opposite page) offers a price perspective on 24-row model planters built in 2019. For extra measure I calculated the average dealer prices and price ranges for John Deere 1775NTs from the past six years.

2015

16-row

Average price: **\$113,910**

Price range: **\$79,000 to \$151,000**

24-row

Average price: **\$167,925**

Price range: **\$134,500 to \$228,800**

2016

16-row

Average price: **\$123,357**

Price range: **\$77,500 to \$160,000**

24-row

Average price: **\$189,769**

Price range: **\$139,900 to \$229,900**

2017

16-row

Average price: **\$139,582**

Price range: **\$85,000 to \$175,900**

24-row

Average price: **\$204,215**

Price range: **\$139,900 to \$265,250**

2018

16-row

Average price: **\$164,850**

Price range: **\$89,500 to \$294,500**

24-row

Average price: **\$231,690**

Price range: **\$139,500 to \$294,500**

2019

16-row

Average price: **\$172,801**

Price range: **\$90,000 to \$225,100**

24-row

Average price: **\$245,860**

Price range: **\$179,500 to \$297,800**

2020

16-row

Average price: **\$192,710**

Price range: **\$145,000 to \$234,900**

24-row

Average price: **\$313,785**

Price range: **\$199,500 to \$339,000** **SF**

Horsepower and Planter Size Comparison

Earlier this summer, while checking fields on a drive with my dad, he pointed out low strips running the length of our neighbor's cornfield, equally spaced about every 100 feet. He explained that our neighbor had purchased a new 48-row planter, and the weight from the central fill and large four-wheel-drive tractor pulling it had caused compaction in those rows.

We began debating the pros and cons of such a large planter. There are consequences to every decision, and farm equipment is no different. It is just a matter of understanding all the facts and implications for your operation.

Since I was riding shotgun, I pulled up IronComps.com Insights on my phone to understand the value of one of these 36- or even 48-row planters. I was surprised by some of the good deals that other farmers had found at auction, especially relative to what a new one would cost. For example, just last year, a good condition 36-row Kinze 3700 sold for just \$22,000.

Besides the price, another important consideration with implements this large is how to pull it. Some of the manufacturers recommend at least 350 horses to pull a 48-row planter. This can force an operation to add more

horsepower per acre than originally planned.

I was curious to know the difference in the horsepower of farmers' tractors between those who own a large (36- or 48-row) planter compared with those with a more moderate 24-row unit. For this study, I pulled data from IronComps.com Insights feature because it allows you to filter auctions by type.

I set the filter to only include estate and retirement auctions. This way, I could be certain that I was getting a snapshot of an individual farmer's fleet and not a random collection of many farmers' implements at a consignment auction. Finally, I split those auctions into two groups. The first sold 24-row planters and the second sold 36- or 48-row planters. Of those two auction groups, I looked through the data to see what percentage of tractors sold were in different horsepower ranges. You can see that in the table below.

There is no doubt that the larger planters require a larger tractor. What may be most surprising is that the farms that had a large

planter had so few tractors with less than 300 hp.

A 24-row unit may only be half the width of a large planter, but it's still not a small implement. For those auctions selling a 24-row planter, you find significantly increased horsepower compared with all tractors sold at retirement and estate auctions, as seen in the bottom line in the table.

As we approach late winter and early spring, there are likely to be a good number of quality planters sold at auction. Be aware that the size of planter may have a significant influence on the subsequent size of tractors on your farm. •

By Andy Campbell
IronComps.com

TRACTOR HORSEPOWER RANGE

	100 to 174 hp.	175 to 299 hp.	300+ hp.
With 24-row planters	28%	34%	39%
With 36- and 48-row planters	11%	22%	67%
Distribution of all tractors sold	51%	32%	17%

Cut along this line



Cut along this line



POCKET PRICE GUIDE: Dealer Asking Prices on 2019 24-Row Planters

MAKE & MODEL	PRICE	SPECIFICATIONS
Case IH 2150	\$239,000	24-30 bulk w/ scale, two-stage air closing, Clean Sweep, Delta Force, elec. shutoff, high-speed tubes, hyd. downforce
	\$175,000	Elec. drive meter, hyd. direct drive, auto. hyd. down pressure, two-stage closing in-cab control, row markers, AFS control
John Deere 1775NT	\$265,000	CCS, Row Command, elec. drive, liq. fert., gen., downforce, EZ Fold Seed Star 4, pneu. row cleaners & coulters, markers
	\$289,500	CCS, ExactEmerge, Row Command, elec. drive, gen., single spoked gauge wheel, hyd. downforce, BrushBelt delivery system, pneu. row cleaner, markers
	\$257,500	CCS, ExactEmerge, elec. drive, single gauge wheel, pneu. downforce, BrushBelt, marker, frame wgt. dist., steel scraper
	\$269,400	CCS, MaxEmerge, elec. drive, single spoked gauge wheel, hyd. downforce, AccuCount Sensor, pneu. row cleaner, frame wgt. dist.
	\$279,900	CCS, ExactEmerge, elec. drive, gen., single gauge wheel, hyd. downforce, BrushBelt, pneu. row cleaner, fluted coulter row cleaners
	\$297,400	CCS, ExactEmerge, dual Surefire fert., elec. drive, gen., single gauge wheel, hyd. downforce, pneu. closing wheels & row cleaner, BrushBelt
	\$220,000	CCS, Row Command, MaxEmerge 5, var. drive, Pro-Shaft Drive, pneu. downforce, AccuCount sensor, markers, steel scrapers
	\$218,000	CCS, Row Command, MaxEmerge 5, var. drive, Pro-Shaft Drive, pneu. downforce, AccuCount sensor, markers, insect. system
	\$279,900	CCS, ExactEmerge, frame wgt. dist., elec. drive, gen., scrapers, hyd. downforce, pneu. row cleaners, scales
	\$241,500	CCS, ExactEmerge, elec. drive, single spoked gauge wheels, pneu. downforce, BrushBelt, screw adjust row cleaner, markers, frame wgt. dist.
	\$265,000	CCS, ExactEmerge, elec. drive, single gauge wheels, BrushBelt, fluted coulter, pneu. row cleaner, markers, frame wgt. dist., hyd. downforce
	\$219,000	CCS, MaxEmerge, elec. drive, single gauge wheels, hyd. downforce, AccuCount sensor, frame wgt. dist., steel scrapers, fluted coulter
	\$274,900	CCS, Row Command, elec. drive, single gauge wheels, hyd. downforce, BrushBelt, pneu. row cleaner, markers, frame wgt. dist
	\$246,000	CCS, ExactEmerge, Row Command, elec. drive, gen., single gauge wheels, steel scrapers, hyd. downforce, BrushBelt, pneu. row cleaner
	\$275,000	CCS, ExactEmerge, elec. drive, steel scrapers, hyd. downforce, pneu. closing wheel, pneu. row cleaner, frame wgt. dist., markers
	\$295,800	CCS, Exact Emerge, elec. drive, steel scrapers, hyd. downforce, pneu. close wheel, frame wgt. dist., Surefire liquid fert., 750-gal. tank
	\$235,800	CCS, elec. drive, gen., Row Command, MaxEmerge 5, single gauge wheels, steel scrapers, hyd. downforce, AccuCount sensor, pneu. row cleaner, frame wgt. dist.
	\$246,000	CCS, Row Command, MaxEmerge 5, elec. drive, PTO, gen., single gauge wheels, steel scraper, hyd. downforce, pneu. row cleaner, frame wgt. dist.
	\$179,500	CCS, MaxEmerge, var. drive, Pro-Shaft drive, Row Command, steel scrapers, pneu. downforce, AccuCount sensor, row cleaner w/ fluted coulter
	\$209,900	CCS, Row Command, elec. drive, gen., MaxEmerge 5, hyd. downforce, AccuCount sensor, pneu. row cleaners, markers, tire scrapers
	\$224,900	CCS, elec. drive, gen., steel scrapers, AccuCount sensor, pneu. row cleaners, markers, frame wgt. dist., tire scrapers
	\$201,500	CCS, Row Command, MaxEmerge 5, var. drive, Pro-Shaft drive, AccuCount sensor, row cleaner w/fluted coulter, frame wgt. dist., markers
	\$249,500	Rebuild w/ \$14,000 in new seed boot canisters, belts, blades; Exact Emerge, SureFire fert., hyd. downforce, pneu. row cleaners
	\$214,500	CCS, ExactEmerge, elec. drive, steel scrapers, pneu. downforce, BrushBelt, pneu. row cleaners, rear hyd. outlet, bowls for corn, beans, sorghum, cotton, and popcorn
	\$184,950	CCS, Row Command, Dawn row cleaners, MaxEmerge 5, var. drive, Pro-Shaft drive, pneu. downforce, tire scraper, 750-gal. tank, liquid fert.
	\$279,900	CCS, ExactEmerge, elec. drive, gen., steel scrapers, hyd. downforce, BrushBelt, pneu. row cleaners, markers, frame wgt. dist.
	\$288,900	CCS, ExactEmerge, Row Command, elec. drive, gen. steel scrapers, hyd. downforce, BrushBelt, markers, frame wgt. dist., Dawn row cleaners
	\$254,500	CCS, ExactEmerge, elec. drive, single gauge wheels, steel scrapers, hyd. downforce, BrushBelt, tire scrapers, Dawn screw adjust row cleaners
	\$285,000	CCS, ExactEmerge, elec. drive, single spoked gauge wheels, steel scrapers, hyd. downforce, pneu. closing wheels, BrushBelt, pneu. row cleaners, markers, frame wgt. distribution
Kinze 4900	\$189,000	CF, Row Command, elec. drive, Clean Sweep row cleaners, scale, wgt. transfer, flip-over axle, hyd. downforce, Furrow Cruiser press wheels
	\$189,500	CF, Row Command, elec. drive, Clean Sweep row cleaners, Blue Vantage monitor, hyd. drive generator
	\$169,500	CF, hyd. drive, no-till coulters, Keaton seed firms, steel scrapers
White 9824VE	\$179,500	CF, Precision Planting V-set meter, Delta Force down pressure, Wave Vision seed tube sensors, PTO pump with reservoir tank, 20/20 monitor
	\$217,500	Approx. 4,000 acres, 90-bu. CF., variable rate, Dawn adjust. row cleaners with leading edge coulter, Schlagel closing wheels
	\$204,900	CF, liq. fert. in furrow with shutoff sections, Dawn curved tine closing wheels, 20/20 monitor Clean Sweep system, Delta Force, PTO pump

All planters listed had row units set at 30-inch spacing. * auto. = automatic, CCS = Central Commodity System, CF = central fill, elec. = electric, fert. = fertilizer, frame wgt. dist. = frame weight distribution system, gen. = generator, hyd. = hydraulic, insect. = insecticide, var. drive = variable drive
Data sources: MachineryFinder.com, TractorHouse.com, FastLine.com



TIRE DESIGN ADVANCES

Expanded use of very high flexion technology and a new traction lug design highlight tire introductions.

By **Dave Mowitz**, Executive Editor

Tire performance was enhanced by a slew of advances aimed at boosting carrying capacities using lower inflation pressures (which also cuts soil compaction) by employing very high flexion (VF) technology. VF tires can carry loads that are 40% heavier than identical size standard radial tires while running at the same inflation pressures.

BKT's Agrimax V-Flecto tractor tire (pictured above left) line not only has VF technology but also offers improved self-cleaning properties and higher road speeds. Also, the tire line features options that allow mounting the V-Flecto tires on standard-size rims.

The new lug angle design on the tire reduces vibration and noise levels to enhance safety and comfort in the field and on the road. The special polyester casing on the V-Flecto rapidly regains its correct shape even after sitting idle for long periods. For more information, go to bkt-tires.com.

Reduces Soil Compaction

Traction tires have undergone numerous tweaks to their general lug design. The

alternating angled lugs of the R-1 agriculture tread have remained basically the same over the decades – until Nokian introduced its Ground King line (pictured above right). This tire features a unique hybrid lug pattern, call the Hybrilug, that the company contends offers the best of both worlds: a lug pattern for traction and block pattern to improve on-the-road ride.

Four sizes of the Ground King line became available to dealers last spring; additional sizes have been added recently. For more information, go to nokiantyres.com.

High-Speed Implement Tire

The all-steel VF radial implement tire from Alliance, the Agriflex+ 881 (shown below), is rated for road speeds up to 40 mph. The tires' cross-cutting rib tread pattern enhances traction on loose soil and also spreads implement loads evenly which reduce soil compaction.

All-steel construction resists punctures and maintains a longer footprint. Steel radial belts and woven steel carcass plies also dissipate heat more effectively than other corded materials. This is crucial when running implements up to 40 mph. Also, the rubber composition in the tire includes a stubble guard compound to reduce damage from crop residue and road wear.

"We look at every machine that touches the field and seek to provide farmers with a low-compaction tire to help protect their yield potential," says Nick Phillippi of Alliance Tire Americas. "When you look at research about soil compaction – which can reduce yields for years – you see that it's caused not just by the heavy, high-profile machinery like tractors and combines or sprayers, but also from planters and drills, grain carts, and all sorts of other towed equipment."

The Agriflex+ 881 line is currently offered in VF 295/75R22.5, VF 255/70R22.5, and VF 445/65R22.5 sizes. Additional sizes will be available soon. **SF**





Sean and Kat Weinert love ranching with daughters (from left to right) Maggie, KayCee, and Charlee.

OUT OF THE BOX

Ignoring naysayers while considering creative options can open doors.

By Raylene Nickel

Hettinger, North Dakota, ranchers Sean and Kat Weinert learned at the outset of their ranching career that they would have to ignore the negative outside messages boxing them in if they were going to have a fighting chance at opening the doors to a life of ranching.

For Sean, who grew up in Montana with no ranch background, the negative messages from established farmers and ranchers began back in college.

“I had dreams of owning my own ranch someday,” he says. “I didn’t know what it would look like or how this dream would be accomplished. I seldom told anyone about my ambitions because when I did talk about it, I was told that I wasn’t born into that life. What did I know about ranching? I was told I could never afford to get into that business.”

Today, the Weinerts and their three children own the Lost Creek Cattle Company. Their ranch headquarters sits on 140 acres of land they bought and paid for in five years. They lease another 1,000 acres

of grassland for grazing their herd of 120 cows. They have worked at jobs in town as needed to meet financial goals, while Kat’s home-based photography business has now grown into a family-sustaining enterprise. No surprise that the Adams County Farmers Union recognized them with a Young Farm Family of the Year award.

The universal lessons the Weinerts learned about the importance to success of ignoring “negative messages” applies to any work or walk of life.

“Ever since we began our journey,” says Sean, “we have heard that it is impossible to get into farming and ranching unless you are born into it or have a spouse who is. We continue to hear this message, along with a new one: Because there is no money in it, there seems to be no hope for anyone in production agriculture.

“These negative messages are a disease that, if repeated often enough and long enough, will eventually be believed by most people,” he says. “Horse clinician Buck Brannaman once said, ‘If all you are thinking about is your horse bucking you off, it will become a self-fulfilling

prophecy.’ I believe the same holds true in business. If we only focus on the negative, we will only get the negative.”

Before buying their ranch, the couple was surrounded by well-intentioned but negative outside voices telling them the place wouldn’t support them.

“Our friends and family pointed out that the house was in a shambles and told us that the place was not for us,” says Kat. “But one of my aunts encouraged us to fight for it.”

They did just that. Ignoring the naysayers, they bought the ranch, gutted the house to restore it, and made the place their headquarters. “I can’t imagine living anywhere else,” says Kat, who was raised on a ranch in western North Dakota.

Both positive people, Sean and Kat are helping themselves achieve their goals by keeping a close eye out for opportunities, some obvious and others hidden within the challenges themselves. They found, for instance, that the price of the ranch was fair. As was the price and purchase arrangement of the first set of 20 cows they bought.

Besides finding such out-of-the-norm financial breaks from generous people, the Weinerts discovered good ideas, encouragement, and challenge coming from others with positive



outlooks who are willing to think outside the box. This had led the Weinerts to insightful practices related to ranching.

“We learned that through the right genetics, proper grass management, and working with nature, a decent profit can still be made in this business,” says Sean. The Weinerts direct-market grass-fed beef and sell forage-developed bulls through Pharo Cattle Company.

“We ended up intentionally surrounding ourselves with positive people who helped us look beyond the status quo and showed us there were better ways to do things,” says Kat.

Adds Sean, “There is no doubt that money is tight in agriculture, but that does not mean that success is impossible. I believe there is a lot of opportunity out there if we will only go out and find it.”

Practical Steps to Change

Soil health educator Jon Stika, formerly a soil scientist with the North Dakota Natural Resources Conservation Service, encourages farmers and ranchers to think about their goals, practices, and problems in new ways. While Stika’s focus is soil health, his principles apply to any

enterprise in any walk of life.

Stika encourages farmers and ranchers to ask enough “why” questions to uncover the root cause of problems relating to soil health. Applying the same process to broader issues could uncover new ways of thinking about your choices. Or it could lead to creative management twists that could wring solutions out of problems.

Illustrating how asking “why” can uncover the root cause of soil erosion, for instance. “A farmer might tell me, ‘I have soil being carried away by water erosion.’ I encourage him or her to ask why,” Stika says. “The answer is, the water is not infiltrating. Why? Because the soil aggregates are poorly formed. Why? Because there’s not enough biology in the soil to make stable soil aggregates. Solving the problem of water erosion requires making the changes needed to build life in the soil.”

Stika offers the following five tips for envisioning and implementing creative change.

• **Set a goal.** “Write down your goal,” he says. “You might describe your farm as you would like it to be.”

Consider that fixing the symptom of a

problem is not a legitimate goal. For instance, soil erosion is a symptom. Because the problem is dysfunctional soil, the goal would be to develop healthy soil.

• **Keep learning.** Seek new knowledge about your goals, problems, and potential tools that might address the problems. “You typically need to hear something from multiple sources before you try it, especially if it’s something out of the box,” says Stika.

• **Ask why.** Asking enough “why” questions eventually leads past the symptoms, past the tools, and helps uncover the heart of the problem.

• **Start small.** Experiment with change on a small scale. “Overcome inertia by doing something simple to begin with,” he says.

• **Be patient.** Because the results of change take a while to evolve, Stika suggests giving experimental practices enough time to demonstrate their benefits.

“If you’re trying to improve biology in degraded soil, for instance, consider that it takes three to four years for the soil biology to regenerate and start to show the benefits of better water infiltration and improved residue breakdown,” he says. **SF**

Learn More

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Those who have made the Menoken Farm a reality have focused on five pillars of soil health.



A FARM FOR THE FUTURE

The Menoken Farm shows an integrated approach to soil health.

By Raylene Nickel

Building soil health through a systems approach is the focus of the Menoken Farm near Bismarck, North Dakota. Owned and operated by the Burleigh County Soil Conservation District (BCSCD) as a demonstration site since 2009, the 150-acre farm shows visitors what's possible when soil is managed for the end aim of rejuvenating soil function.

The farm's goals go far beyond "conserving degraded soil," says Jay Fuhrer, an internationally recognized soil health specialist now retired from the Natural Resources Conservation Service while retaining his affiliation with the Menoken Farm.

"When you focus on rejuvenating soil by putting carbon back, the work comes with some excitement," he says. "Visitors to the farm see what we're doing, and they get excited. They want to go home, take a degraded field, and build health back into the soil on their own farm."

The Menoken Farm demonstrates the synergy among five pillars of soil health: soil armor, minimized soil disturbance, plant diversity, continual cover of live plants and roots, and livestock integration. "The five

principles of soil health are intended to be applied in a systems approach, maximizing the soil-building impact," says Fuhrer.

5 Soil Health Principles

Over the past decade, Fuhrer and the BCSCD staff implemented the five soil health principles in an integrated step-by-step process that evolved over time in the farm's 10 fields. Following is how they did it.

1 Focusing on establishing soil armor.

"The farm had been conventionally tilled, so we started with bare soil," says Fuhrer. "Our primary focus at first was to put a cover on the soil."

Covering the soil protects it from heat, reduces evaporation of moisture from the surface, and shelters it from wind and water erosion.

"Erosion needs to be controlled before you can build soil health," says Fuhrer. "The soil armor also provides a protective habitat for the soil food web's surface dwellers. Our goal is to cover 100% of the soil with a green plant/residue during the growing periods and residue during the dormant periods."

2 Minimizing soil disturbance. "We used no-till seeding to reduce soil disturbance, thus, creating a more suitable environment

for the soil food web and plant root growth," says Fuhrer.

3 Establishing plant diversity. The crop rotation includes crops from all four crop types: warm-season grass, warm-season broadleaf, cool-season grass, and cool-season broadleaf.

4 Establishing the continuous presence of live plants and roots.

Adding cover crops to the rotation further increases diversity and extends the season for growing live plants. Cover crops may include annuals, biennials, and perennials.

After five years of growing diverse annual crops, the Menoken Farm added perennials to the crop rotation to further enhance plant diversity.

"We planted a mix of 21 species of perennials, including flowering forbs, legumes, and cool- and warm-season grasses," says Fuhrer. "The biodiversity provided by diverse crop rotations benefits the soil food web. This, in turn, helps build soil aggregates, which improve rainfall infiltration and nutrient cycling, while reducing disease and pests." After five years of managed grazing, the perennial pastures are returned to annual crop production.

5 Integrating livestock grazing into the system.

The Menoken Farm initially introduced grazing by using cattle to harvest crop residues and cover crop growth. Later, the farm combined cattle and sheep to rotationally graze ▶



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the annuals, biennials, and perennials.

“The managed grazing of livestock helps balance the carbon-nitrogen ratio in the crop residue,” says Fuhrer. “The ruminant converts high-carbon crop residue to a lower-carbon organic material. Spring or summer grazing of cover crops with short exposure periods followed by long recovery periods allows the plants to regrow and harvest additional sunlight and carbon dioxide.”

After a decade of being managed by integrated regenerative practices, the previously bare soil of the Menoken Farm is now covered by an armor of surface residue. Still, Fuhrer has learned over time that maintaining the cover requires vigilance.

“When you start with bare soil, the soil biology is accustomed to that condition – it’s adapted,” he says. “Because initially the primary decomposers aren’t always there, the first layer of cover lasts quite a while. As the system gets older, the biology starts to cycle the residue more rapidly, creating the need for continuing influxes of organic material. When we first started, I was thinking we just needed to maintain dead surface litter. Now, I believe the best sources of cover are green plants mixed with dead litter.”

A yardstick Fuhrer uses to indicate progress in soil health is the formation of soil aggregates. “We archived samples of the farm’s soil before we started,” he says. “When I look at that soil today, it looks nothing like the soil we’re presently working with.”

Building stable soil aggregates is the critical cornerstone of improving soil health, he says. Well-formed soil aggregates improve water infiltration and lead to increases in soil organic matter.

One lesson Fuhrer has learned for sure? “Rejuvenating soil is a process,” he says. “Our work has given us a glimpse into a wonderfully complex system that we don’t yet fully understand.”

A Regenerative Farming Showcase

Visitors to the Menoken Farm get a close-up look at a systems approach to regenerative agriculture.

“The systems approach to management may seem a bit out of the box,” says Darrell Oswald, farm manager and BCSCD technician. “Our crop-production system includes no-till seeding, high-crop diversity, and rotations with cover crops. This creates a regenerative environment for the soil biology.”

Livestock play a key role in the integrated cropping and grazing system. Cattle,

sheep, and chickens grazing together demonstrate the synergistic effect of multi-species grazing. “We believe diversity in livestock is as important as diversity in plants,” says Oswald.

The popularity of the Menoken Farm as a destination place for visitors suggests the growing interest among farmers large and small in alternative agricultural options.

“In 2019, we hosted more than 40 groups,” says Oswald. “Our visitors come from all across the U.S. and from around the world. People want to see soil health regeneration in practice. They’re looking for alternatives to the current model of production agriculture.”

Through its special events, workshops, and on-farm demonstration activities, the Menoken Farm aims to serve urban food producers as well as family farmers. Along with an arboretum and a composting demonstration site, the farm features an outdoor garden and a high-tunnel garden.

“Our goal is to educate and empower people to grow some of their own food,” says Oswald. “The soil health principles can be used on any scale – large or small.” 

Learn More

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FOR SOME, IT'S ABOUT COMMUNITY. LIVING THE LIFE
YOU WERE MEANT TO LIVE. WHILE WE ALL MAY DO IT FOR
DIFFERENT REASONS, **THERE IS ONE THING THAT UNITES US.**
ONE THING THAT WILL NEVER CHANGE. AT THE HEART OF IT,
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Water is diverted into the perforated distribution pipe for denitrification.

SATURATED BUFFERS ARE KEY TO REMOVING NITRATES FROM TILE DRAINAGE

This edge-of-field conservation practice is effective, affordable, and easy to maintain.

By Megan Schilling
Agronomy & Technology Editor
megan.schilling@meredith.com | [@meganjoyv](https://twitter.com/meganjoyv)

Lee Tesdell farms 80 acres near Huxley, Iowa, that have been in his family since 1884. To maintain such a legacy, he's adopted a long-term view of sustainability and strives to make his farm an example of the impact conservation practices have on soil health and water quality.

Tesdell and row-crop operators Mike and Charles Helland work together on the farm's management, which, over time, has grown to include a no-till corn/soybean rotation, cover crops, a waterway with native grasses, brome grass buffer strips, a wood chip bioreactor, and prairie strips.

In addition to addressing erosion concerns and a leaky system with excess nutrients in

the fields, Tesdell installed a saturated buffer in 2017 as another layer to further improve the water entering his creek.

"The land and creek have benefited because of strong vegetation in buffer strips already and microbial activity even before putting in the saturated buffer system," Tesdell says.

The farm's two edge-of-field practices have reduced the nitrogen load into the nearby waterway. The wood chip bioreactor has reduced nitrates by 53%, according to data collected since May 2014. Data collected since 2018 show denitrification with the saturated buffer at 91%.

The Power of a Saturated Buffer

A saturated buffer intercepts tile drainage water before it outlets into a stream. The

water is diverted by a water-control structure through a perforated drainage pipe and then pushed through an existing filter strip. As the water drains through the soil profile, perennial plants take up the excess nutrients.

Keegan Kult, executive director at the Agricultural Drainage Management Coalition (ADMC), attests to the effectiveness of saturated buffers.

"Most times, we'll see denitrification right away, and we have been noticing some higher denitrification rates on well-established buffers," Kult says. "If a saturated buffer is installed in a new filter strip where we're just getting that perennial vegetation planted, the reduction rate might not be as high. But we still see a pretty good reduction in those scenarios, because it's really the organic matter in the soil that makes a difference."

Ag Drainage Management Coalition and FSA Study

This year, the FSA and ADMC released findings of a study after monitoring seven saturated buffer sites across Iowa, Illinois, and Minnesota between October 2017 and August 2018.

According to Kult, the study's first goal was to add to the current data set and validate the nitrate concentration reduction per field, which averages 41% to 98%, and nitrate load

MULTIPLE SOAs: THE BEST WEED CONTROL OPTION

The easiest weeds to control are those that never emerge. Cliché? Maybe. But as weeds continue to adapt, mounting resistance to herbicides builds every year. Sustainable control has become increasingly more challenging to achieve.

The over-reliance of a single site of action (SOA) continues to provide new challenges for weed control in soybeans with each growing season. XtendFlex® soybeans will help farmers focus on the basics of a sound weed management system — multiple SOAs and overlapping residuals, all without having to compromise performance and yield.

Sustainable weed control is only possible through the incorporation of a herbicide program that utilizes multiple effective SOAs. Beck's multi-year Practical Farm Research (PFR)® data has demonstrated the impact and importance of utilizing a pre-emerge program with multiple SOAs (Figure 1).

ADVANTAGES OF THE XTENDFLEX® SYSTEM

XtendFlex soybeans feature the benefits of the Roundup Ready® Xtend Crop System with the addition of tolerance to glufosinate. This allows access to multiple effective herbicides to manage each of your fields' unique weed challenges. Beck's PFR studies on the effectiveness of combining glufosinate and glyphosate show they are a powerful tool against tough-to-control waterhemp.

POWER IN THE PRE™: Controlling weeds early with a pre-emergence application not only reduces the likelihood of developing resistance, but it also protects soybean yields. The over-reliance on POST

programs to control early-emerging weeds is unlikely to provide results and could cause yield losses of up to 2.5% for every growth stage you delay your applications. Put the Power in the Pre™ and let your pre-emergence applications do the heavy lifting. Post-emergence applications can then be used as rescue treatments for weed escapes.

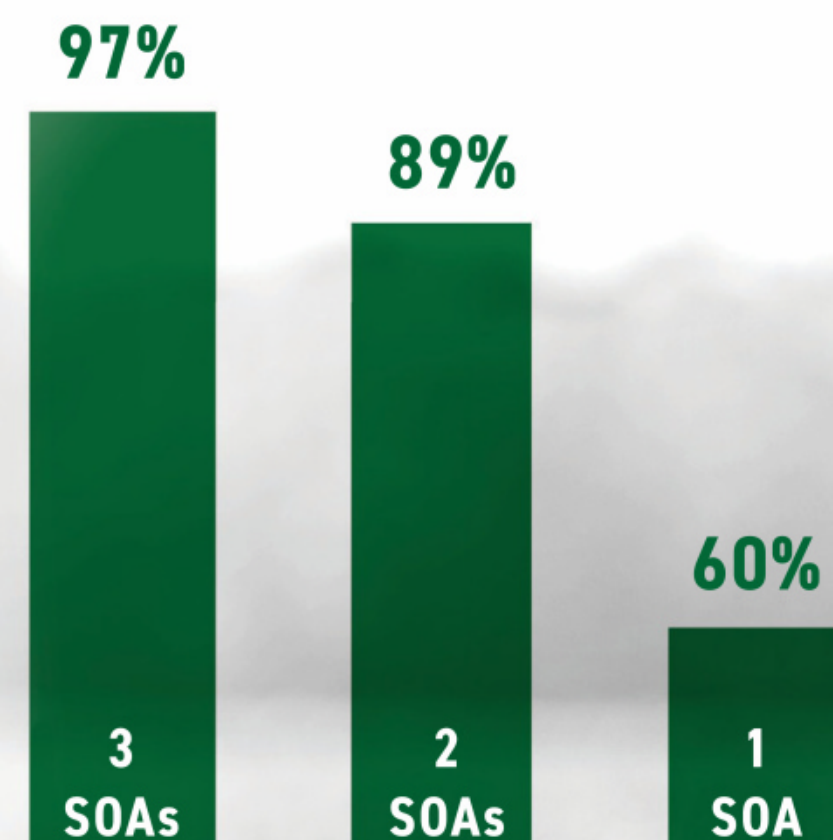
POWER OF MULTIPLE SOAs: In-season, Liberty® will provide effective post-emergence control of weeds such as waterhemp, kochia, and giant ragweed. XtendFlex soybeans provide post-emergence tolerance to multiple SOAs to control resistant broadleaf weeds. Now farmers can confidently pursue higher yields by making early-season herbicide applications and maintain the option of spraying Liberty over-the-top once crops have emerged.

POWER OF HIGH-YIELDING GERmplasm: Backed by uncompromising yield potential and outstanding agronomic performance in all maturities, XtendFlex® soybeans are built on the same proven genetic performance of high-yielding Roundup Ready 2 Xtend® soybeans, now with the power of Liberty herbicide.

While weed control continues to provide new challenges with each growing season, you will have the option to bring the power to your soybean platform in 2021 with XtendFlex soybeans.

The EPA is currently reviewing a new registration for XtendiMax® for the 2021 season and beyond.

FIGURE 1: INFLUENCE OF MULTIPLE SOAs ON WATERHEMP CONTROL
(% VISUAL CONTROL)



RIGHT: Number of SOAs (Pre-Emerge)
Influence on Waterhemp Control from Beck's multi-year Practical Farm Research (PFR)® data.

ALWAYS READ AND FOLLOW DIRECTIONS FOR USE ON PESTICIDE LABELING. IT IS A VIOLATION OF FEDERAL AND STATE LAW to use any pesticide product other than in accordance with its labeling. NOT ALL formulations of dicamba or glyphosate are approved for in-crop use with Roundup Ready 2 Xtend® soybeans. ONLY USE FORMULATIONS THAT ARE SPECIFICALLY LABELED FOR SUCH USES AND APPROVED FOR SUCH USE IN THE STATE OF APPLICATION. Contact the U.S. EPA and your state pesticide regulatory agency with any questions about the approval status of dicamba herbicide products for in-crop use with Roundup Ready 2 Xtend® soybeans. Products with XtendFlex® Technology contains genes that confer tolerance to glyphosate, glufosinate and dicamba. Glyphosate will kill crops that are not tolerant to glyphosate. Dicamba will kill crops that are not tolerant to dicamba. Glufosinate will kill crops that are not tolerant to glufosinate. Contact your seed brand dealer or refer to the Bayer Technology Use Guide for recommended weed control programs. XtendFlex®, Roundup Ready 2 Xtend® are trademarks of Bayer Group. Liberty® is a registered trademark of BASF.





The saturated buffer includes a multichamber control structure that diverts water flow.

reduction between 10 and 194 pounds.

The second goal of the study was to determine the scalability of saturated buffer sites and the potential impact of a reduced nitrate load.

“We contracted with the department of crop sciences at the University of Illinois. The group did a modeling run for us to try to determine the number of sites that would be available. That’s where the conservative estimate of 46,920 miles of cumulative stream bank suitable for saturated buffers was identified,” Kult says.

In all, that means about 9.5 million acres are potentially suitable for saturated buffers across the Midwest, about 22% of the tile drained landscape. The study found that with this potential, 5% to 10% of the tile-contributed nitrate load could be removed.

“T How to Get Started

his is one of those practices that, if you have the right spot, it’s kind of a no-brainer,” says Kult. “It’s relatively

inexpensive compared with other practices, as the average cost is \$2,000 to \$4,000 per site. There’s also not a lot of maintenance that goes with it, so once you have it out there, it should be doing work for you for quite a while.”

State water-quality initiatives, Environmental Quality Incentives Programs, and Conservation Reserve Programs often provide up to 100% cost share.

If you’re interested in getting started with a saturated buffer, Kult recommends starting with your local Natural Resources Conservation Service office to find out which program will work best for you.

Keep in mind that, due to design standards, the NRCS will need to complete a survey of the saturated buffer site, and a finished design won’t just happen overnight.

“It takes about six months to a year for the practice to actually get installed from the time you go sign up for it,” says Kult.

However, once the buffer is designed and there is a window for installation, a contractor only needs about three hours to get the project wrapped up from start to finish.

Characteristics of a Saturated Buffer Site

Once you kick off the design process, your local NRCS office will help to determine suitability of a site on your farm, which includes the following eight standards.

- 1. Must have a tile outlet crossing an existing or planned buffer that can be intercepted.**
- 2. Must drain a suitably large enough area to provide sufficient flow and treatable nitrate levels.**
- 3. Buffer must be at least 30 feet wide and planted with perennial vegetation.**
- 4. Loam or clay loam is ideal.**
- 5. Soil must have a high water table.**
- 6. Soil should contain at least 1.2% organic matter to a depth of 2½ feet to support denitrification.**
- 7. Buffer should be lower in elevation than the field.**
- 8. Stream bank should be less than 8 feet high. **

Scan this smart code using your smartphone to watch footage of a saturated buffer installation on June 6, 2019, at Ken Fawcett’s farm near West Branch, Iowa. Or, type in this URL in your browser: [Agriculture.com/video/installing-a-saturated-buffer-to-improve-water-quality](https://agriculture.com/video/installing-a-saturated-buffer-to-improve-water-quality).



3 AG TECH START-UPS TO WATCH IN 2021

Programs connected to state universities boost industry collaboration for innovative entrepreneurs.

By Laurie Bedord
Executive Editor, Ag Technology
Laurie.Bedord@meredith.com | @BedordLaurie

Universities have a long history of encouraging innovation in agriculture through research and launching generations of graduates. Moving those ideas from the campus into the world, however, can be a challenge. By creating a network of industry players, Midwestern universities are addressing this gap.

The Edge Collaboration District

The Edge Collaboration District is a partnership between Kansas State University and the KSU Foundation to inspire industry collaboration along the northern edge of the campus. “It’s where industry, research, and talent come together to produce meaningful innovations and real outcomes in Kansas and beyond,” says Kate Ryan, commercial leasing and engagement manager, KSU Foundation.

With approximately 5,000 jobs expected to be housed in the corridor by 2035, the university is well positioned to advance America’s heartland through innovative research and collaborative partnerships.

Focused on global food initiatives, Fulcrum Global Capital is always on the lookout for technologies that maintain or increase yield with a more biological, and less chemical or antibiotic, solution; reduce food waste; and improve food safety.

In addition, the innovations must have a sufficient and obvious return on investment (ROI) for the producer. The time frame of that ROI often gets missed, says Kevin Lockett, a partner and chief financial officer at Fulcrum Global Capital.

“In agriculture, many times the ROI is the actual growing season, because each one is different,” he says. “Farmers are looking

for a very short time period when they’ll at least break even by trying a technology. If it is truly value added, over time there will be an increase in benefit and, hopefully, in margin.”

It’s also why many of Fulcrum’s investors, who represent 13 states across the Midwest, are row-crop and livestock producers.

“We want people who sign the front of the check, not just the back of the check — people who have to make these innovations work and can potentially help prove their effectiveness,” he says. “As we think about some of the strengths of Kansas State University, especially on the animal health and grain side, finding a way to partner with the university made a lot of sense as well.”

About a year ago, Fulcrum opened an office at the K-State Office Park in the Edge District. By the end of 2020, its investment team, which also includes Duane Cantrell and John Peryam, had considered more than 300 investment opportunities in one year.

Start-ups that have gone far in their process possess certain qualities. First, the problem being solved has to matter. “It has to be a billion-dollar problem,” Lockett says.

Because they invest at the Series A round, which is beyond proof of concept, there also has to be a solid team behind the idea.

“At this stage, we’re investing in the people as well,” Lockett says. “Those individuals must have the ability to pivot, understand what the market is looking for, and provide a solution to a very big problem in an economical way that makes sense for the end user.”

To date, the venture fund has seven companies in its portfolio. A number of others are on its watch list, including Phoreus Biotechnology.



Founders: Randall Tosh, Michael Coe, and

John Tomich

Headquarters: Olathe, Kansas

Web: phoreusbiotech.com

Background: While trying to develop a peptide-based bioadhesive, KSU scientist John Tomich discovered he’d created self-assembling peptide capsules that were remarkably stable and readily taken up by cells.

Phoreus Biotechnology’s branched amphipathic peptide capsules and lipid-encasing amphipathic peptides substantially increase efficacy in creating and delivering human and veterinary vaccines, cancer therapeutics, alternative antibiotics, diagnostics, and biopesticides.

One of its nanocarrier platforms lets less vaccine be used with precise delivery to specific cells in an animal, reducing the amount of active ingredient required while improving results. Another platform has been demonstrated to make delivery of existing pesticides more effective, reducing both costs and off-target environmental damage.

Purdue Foundry

In recent years, Purdue University has also placed greater emphasis on helping talented individuals commercialize their intellectual property. Launched in 2013, the Purdue Foundry was created at the behest of the university’s president, Mitch Daniels. His directive: develop 25 companies a year based on intellectual property coming out of Purdue.

“Before Mitch became president, [the university was] averaging eight companies a year,” says

Bill Arnold, managing director, Purdue Foundry. “In the past seven years, we have averaged 23 companies a year.”

Since its inception, Purdue Foundry has enabled the creation of 306 companies. A bit over half are based on university intellectual property. Much of the technology being commercialized is coming out of the agriculture, engineering, and science colleges.

“A lot of that is due to the leadership in those colleges, and their commitment to commercializing the technologies being created, many of which are publicly funded,” Arnold says. “For that publicly funded research to make an impact on society is the conclusion of that value chain.”

As with Fulcrum Global Capital, Purdue Foundry seeks ideas that solve a significant market problem and that has teams in place to turn the concept into a company. “You also have to have access to capital, but only after the first two elements are in place,” says Dan Dawes, entrepreneur in residence, Purdue Foundry.

If the idea is simply that – an idea – the foundry’s Firestarter program can help innovators work through the ideation process. The program averages about 20 cohorts a year with seven ideas running through each cohort. By working with creators to determine whether a product solves a real-world problem and customers exist for that product, the experience ultimately leads to stronger business plans and start-ups.

“If two companies are created out of seven in a cohort, that’s a big result. Often only one moves forward,” Arnold says.

NUTRAMAIZE

Founders: Torbert Rocheford, CTO, and Evan Rocheford, CEO

Headquarters: West Lafayette, Indiana

Web: nutramaize.com

Background: Torbert and Evan Rocheford are a father and son working to transform America’s largest staple crop – corn – into a platform that delivers better nutrition for consumers. Originally developed by Torbert, a professor at Purdue University, to reduce malnutrition in sub-Saharan Africa, NutraMaize Orange Corn is now available in the United States.

“The striking color of our Orange Corn

comes from significantly increased levels of carotenoids, the same kind of natural antioxidant pigments that give carrots their orange color and nourishing reputation,” Evan says.

The company does not sell its seed on the open market; instead, it works with potential platform users directly to meet application needs. Yet, a growing line of milled products is being marketed under the company’s Professor Torbert’s Orange Corn brand.

“NutraMaize has already demonstrated the ability of Orange Corn to provide value in a wide variety of applications as a platform technology,” Evan says. “For example, when used as a poultry feed, Orange Corn improves both the nutritional quality of and color depth of egg yolks by significantly increasing their levels of antioxidant carotenoids. Orange Corn doesn’t just make eggs healthier, it also makes birds healthier.”

Ag Startup Engine

Founded in 2016, the Ag Startup Engine delivers funding, mentorship, and support to entrepreneurs with promising early-stage ag tech businesses.

“There is a particular set of challenges for developing and successfully launching new agricultural technologies,” says Kevin Kimle, codirector, Ag Startup Engine. “Growing key relationships, finding the right mentors at the right time, and finding the right capital at the right time are the main challenges. The Ag Startup Engine is a platform for overcoming those challenges.”

Based in Ames, Iowa, the Engine works in tandem with the Iowa State University Startup Factory, Iowa State University Pappajohn Center for Entrepreneurship, and the Iowa State University Agricultural Entrepreneurship Initiative.

“It is developing a process unique to itself, to the Iowa State University Research Park, and to agriculture in the Midwest,” Kimle says. “Our aim is to provide a rich array of relationships, connections, ideas, and alternatives to portfolio businesses so that good choices are made in those key moments.”

Since launching, the Ag Startup Engine’s portfolio has grown to 12 companies. Two of those – Smart Ag and Performance Livestock Analytics – were recently acquired by Raven Technologies and Zoetis, respec-

tively. Another start-up, Distynct, is quickly gaining traction.



Founders: BJ Brugman, CEO, and Thomas Hornbeck, CTO

Headquarters: Ames, Iowa

Web: getdistynct.com

Background: Launched in 2020, BJ Brugman and Thomas Hornbeck recognized a gap in the availability of reliable, accurate, and real-time data at swine production facilities.

“Data on inventory, temperature, manure pit levels, water consumption, feed availability, and more rely on a human to manually collect and report this information, typically with a pen and paper,” Brugman says. “That data rarely makes it back to someone who can turn it into insight. If the information does make it back, the pigs have already been harvested, so there is no action a producer can take.”

By connecting unlimited devices, Distynct automates data collection and reporting that are most important to a producer. Information flows from the barn back to a customized user interface where insights can help direct daily chores more efficiently. It also enables producers to intervene earlier when health issues arise.

In early spring 2020, sensors to monitor manure pit levels, temperature, humidity, water consumption, and feed levels in the bin were deployed. The start-up continues to test other sensors to answer even more questions about swine production. 



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PAY DIRT

How carbon may become another crop for farmers.

Folded arms and furrowed brows among frustrated farmers greeted former Rep. Bob Inglis (R-SC) at a National Corn Growers Association (NCGA) meeting in the mid-2010s.

Inglis was then a rarity among Republican legislators. He made his case for market-based solutions to mitigate the impact of human-influenced climate change.

On that day, though, not many farmers wanted to hear it.

“You could just feel the tension in the room, the feeling that this guy was full of it,” recalls Brandon Hunnicutt, a Giltner, Nebraska, farmer, who is involved with

several NCGA boards.

Many farmers skeptically view the concept of climate change. This skepticism, though, may be as much rooted in fear of government control as distrust in climate science, says Ben Riensche, a Jesup, Iowa, farmer.

“They worry someone who’s never even planted a potted plant in some distant urban

environment will start telling them how to farm,” he says.

The Dawn of Carbon Markets

These days, though, this anxiety is morphing into anticipation over a potential new market. Even if some farmers don’t believe in climate change, they believe in money.

That’s the motivation

By
Gil Gullickson
Executive Editor,
Crops Technology



to claim the mantle of carbon neutrality. This is production that nixes actions or makes swaps to drive carbon dioxide emissions down to zero.

Firms such as Indigo Ag help match firms aiming to be carbon neutral with farmers. Its Indigo Carbon program aims to pay farmers for verified metric tons of carbon sequestered in soils through practices such as no-till and cover crops.

In theory, carbon markets follow this scenario, says Carson Reeling, a Purdue University agricultural economist.

- **A regulator issues a permit that caps the greenhouse gases a company can emit.**
- **If the firm cannot stay within this cap, it offsets the extra amount through a carbon credit measured in metric tons of carbon.**

For example, a farmer may offset an amount

like 100 metric tons of carbon in his or her soil for a firm that exceeds its cap.

- **Carbon offset values depend on where the regulator sets the cap.**

The lower the cap, the more carbon offsets a firm will have to buy from entities such as farmers to meet its cap.

It's here where reality enters and confusion reigns, says Reeling.

"Except for California, we don't have a regulatory cap in the United States," says Reeling. "There is no coordination by the federal government in setting permits and offset credits."

This can create a volatile and perplexing marketplace, he adds. It also runs counter to 67% of U.S. adults who say the federal government is doing too little to reduce the effects of global climate change, according to a 2019 Pew Research Center survey.

Enter the private sector. Indigo Carbon plans to eventually pay farmers \$15 per metric ton of carbon sequestered from companies striving to meet carbon-neutral goals. Payments could tally an estimated \$30 to \$60 per acre, depending on soil type and the region's climate, say Indigo Ag officials.

Nutrien Ag Solution's 2021 program will pay farmers for carbon they preserve based on soil levels at the start and end of the year.

Bayer's Carbon Initiative will generate carbon credits for farmers who adopt new practices like no-till and cover crops. Depending on individual cases, Bayer will pay farmers at year's end \$10 per acre, say Bayer officials.

"As a science-based company, we see climate change as a threat," says Andy Knepp, ▶

Mimic The Prairie

No-till conserves soil and water, but what it doesn't do is consistently sequester carbon. Its success in carbon market programs hinges on use with other tools.

"No-till has a lot of benefits, but soil carbon responses are situationally dependent," says Stuart Grandy, a University of New Hampshire soil scientist. "In some cases, we see no change or a small change in carbon accumulation, while we see a substantial increase in other sites."

A 2006 USDA-ARS study that examined tillage's impact on carbon sequestration found that nearly all cases where conservation tillage, such as no-till, sequestered carbon occurred at depths up to 30 centimeters (11.8 inches). No consistent level of soil organic carbon surfaced at sub-30-centimeter depths in the few studies that existed.

No-till does conserve carbon by nixing its release via tillage. The bulk of the carbon loss, though, is keyed by disruption of plant communities, says Grandy.

"The roots of prairie plants went really deep and created tons and tons of sugars and amino acids that helped create soil carbon," Grandy says. "When the prairies were converted to agriculture, massive amounts of soil carbon were lost."

Farmers can mimic the native prairie by teaming no-till with diverse crop rotations and cover crops, says Grandy.

"Even if it's cereal rye that only grows 5 to 6 inches high, it's producing lots of roots that sequester soil carbon," says Grandy. •

behind carbon farming. Several agricultural firms plan to pay or are paying farmers to raise crops or livestock in ways that sequester greenhouse gases that fuel climate change: carbon dioxide, nitrous oxide, and methane.

Many plans revolve around carbon dioxide sequestration. Businesses that range from beverages to bedding want



Cover crops are a tool that Ben Riensche, Jesup, Iowa, uses in Indigo Ag's Indigo Carbon program to sequester atmospheric carbon dioxide.

agricultural sustainability leader for Bayer Crop Science. "Farmers are a crucial part of the solution."

Bridging Diverse Views

Some farmers are skeptical, though, about the occurrence of climate change: 68% of farmers believed climate change was happening, although just over 10% believed humans cause it, according to a 2013 article in the journal *Environment and Behavior*. Also, 27% of farmers believed insufficient evidence existed

to determine whether climate change is occurring, while nearly 5% said climate change is not happening.

Skepticism also exists about carbon markets. Strategies like no-till coupled with cover crops can build soil carbon levels that help soils better blunt weather extremes like drought and flooding, says Craig Cox, senior vice president for agriculture and natural resources for the Environmental Working Group. Whether carbon stays sequestered is another matter, he says.

"The amount of carbon sequestered long term varies by soil type, weather, and location,"

Cox says. "So to simply say, 'By planting cover crops, you will put this much carbon in the ground and it will stay there' is not sufficient if you're selling carbon credits that allow industries to avoid reducing their own emissions. Another point is that if you abandon the practice that sequesters carbon, some or all of it can be lost into the atmosphere."

Riensche, though, says carbon markets may bridge diverse views.

"There have been several attempts at this over the years," he says, "but the public's never been more concerned about climate change, greenhouse gases, and emissions than they are now. Farmers worry about the same things, but they talk instead of erosion, soil health, nutrient removal, and runoff. We both have the same goal in mind, but we don't speak the same language. Carbon



Craig Cox

is the common denominator we can agree on."

Riensche enrolled 2,000 acres in the Indigo Carbon program for 2020.

Payments had not been determined at press time, but Riensche is realistic about the program's merits.

"This was just year one," he says. We tried some things. Some will work, some will fail,

Carbon Sequestration Synergy

Kelly Garrett, who farms near Arion, Iowa, makes extra money for practices he is already doing – such as no-till – through a pilot carbon sequestration program from Locus Agricultural Solutions called CarbonNOW, which uses Nori's carbon marketplace. Besides no-till, this pilot program also helps farmers pay for



Kelly Garrett

practices like cover crops and applications of compost, green manure, or animal manure.

Garrett sold 5,998 carbon credits in the Nori carbon marketplace last year (one credit equals 1 metric ton of carbon) for \$15 per credit, with 16,752 remaining credits to sell.

Future payments may be more or less than \$15 per carbon credit, depending on market conditions, say officials for the companies.

Garrett also builds soil carbon by applying manure from his cattle operation on as many fields as possible. He's also examining planting cover crops and has diversified his corn and soybean rotation by planting 300 acres of winter wheat in 2020 on soybean ground that was harvested early.

"All these factors form a synergy that ties into carbon sequestration," he says. •

and others will be unforeseen successes."

Moving Too Quickly?

"It's remarkable to me how quickly all this has occurred," says Ferd Hoefner, senior strategic adviser for the ▶

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Although it doesn't come with seeds, stems, and stalks, carbon contained in soil may be a new cash crop for farmers.

programs, he says. Programs such as the Conservation Stewardship Program (CSP) or the Environmental

Quality Incentives Program (EQIP) already pay farmers for practices such as conservation tillage or cover crops.

"All those programs help increase long-term carbon sequestration and increase soil health, reduce runoff, and con-

serve water," Hoefner says. "To me, this is a more straightforward approach, and the return is more secure."

Shortcomings exist, though. Federal programs are subject to the whims of congressional budget cutters, adds Riensche.

Lack of flexibility is also a drawback to federal programs, he says.

"Even well-intentioned people in our government don't have the same incentives to innovate [as private firms]," he says. "The last thing you want is a system that cancels innovation. Using carbon as a proxy, I can change my

model. I can do some things that aren't in the current recipe and see if they are better, whether that's planting filter strips, strip cropping, changing a crop rotation, or more accurately applying nutrients."

Problem Solvers

"Carbon markets have been working in the energy sector for some time," says Debbie Reed, executive director of the Ecosystem Services Market Consortium, a nonprofit partnership of 61 private-sector companies and soil health and environmental groups. The difference, though, ▶

National Sustainable Agriculture Coalition. "In the last two years, many companies have proposed carbon markets or [carbon] policy proposals."

Such programs duplicate many components within existing federal

Questions And Answers

Carbon market payments perk the interest of Brandon Hunnicutt, who farms with his brother Zach and father Daryl near Giltner, Nebraska. Still, he has carbon market questions for practices they use such as conservation tillage and cover crops.

"I compare it to selecting corn hybrids, where every company says theirs is the best one," says Hunnicutt. Unlike corn hybrids, however, Hunnicutt says data on carbon sequestration programs

aren't as readily available.

This concern is justified, says Carson Reeling, a Purdue University agricultural economist. The lack of a federal regulatory structure can create marketplace confusion, as numerous carbon credit coordinators try to align buyers and sellers, he adds. "Farmers are on their own in determining which is worth their time and how it will benefit their farms," he says.

Questions to ask of carbon market companies include the following:

- **Are there up-front costs?** "In my case, the up-front costs were minimal," says Kelly

Garrett, an Arion, Iowa, farmer, who enrolled part of his farm in the CarbonNOW program offered by Locus Agricultural Solutions. Still, checking on this in advance can prevent unpleasant later surprises, he says.

- **How will I be paid?**

Firms compensate farmers for carbon differently, with some paying for the past year while others pay for measures taken in preceding and current years.

"Make sure the money goes to the farmer, and not through a broker or account person," advises Garrett.

- **How will you use my farm's data?** "These companies accumulate data that could be turned into profitable new enterprises for them," says Ferd Hoefner, senior strategic adviser for the National Sustainable Agriculture Coalition. "Farmers have to decide if they want companies to profit off their own data."

- **Ask how programs coexist with federal and state conservation programs.** Firms offering carbon payments may be wary of *additionality* – payment of an environmental or conservation benefit that's already occurring. "If a farmer is paid by a pre-

existing federal or state conservation program to improve water quality, these practices may already generate carbon sequestration 'for free,'" says Reeling. Carbon markets may then not want to pay farmers for a benefit already covered under the government program, he adds.

- **What happens if I violate an agreement?** "In a long-term contract, you may have compaction or drainage issues where you have to till," says Reeling. "Will you have to give back payments from preceding years for [previously sequestered] carbon that goes back into the atmosphere?" •



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\$115

The per-acre payment proposed by the Rural Investment to Protect Our Environment for environmental value created by cover crops.

is that they developed around point sources of pollution. Since agriculture is a nonpoint source with biological emissions, criteria used in the energy markets don't fit with agriculture, she says.

That may be changing. "There is now the feeling that we're at a new tipping point and

these things [in agriculture] will take off," says Hoefner. "The jury is still out, but companies like Indigo have been enormously successful in getting investment money in place. There is a lot of money assuming they are making the right bet."

Ben Pederson, a Lake Mills, Iowa, farmer who

uses carbon-sequestering practices like cover crops and reduced tillage, believes the time has come for carbon markets.

"It's positive as long as we don't make it into a talking point that is frivolous and doesn't have any substance," he says. "We live in a society that rewards problem solvers. At the end of the day, all this can solve a problem and also add value to our crops." 

What Are My Practices Worth?

Farmers may be underselling the worth of their climate-friendly farming practices used in carbon farming systems.

Current carbon payments that hover between \$10 and \$15 per acre do not include the whole value of environmentally friendly practices such as cover crops, says Aliza Wasserman-Drewes, director of Rural Investment to Protect Our Environment (RIPE), a nonprofit group that supports bipartisan climate policy.

Since agriculture is also a solution to mitigating climate change and other environmental goals, RIPE proposes a stacked ecosystem service payment that places a \$115-per-acre value on a corn farmer's contribution of planting cover crops. This per-acre value is for environmental benefits that include:

- **Water quality** \$50
- **Soil health** \$21
- **Water conservation** . . . \$19
- **Carbon sequestration** . \$18
- **Air quality and health benefits** \$7

RIPE estimates the plan's initial phase could cost \$2 billion, with a full plan tallying \$40 billion. Potential funding sources include anticipated stimulus spending, refundable tax credits, expansion of the Commodity Credit Corporation, or inclusion in future bipartisan climate legislation. The \$40 billion cost is significant, but it pales in comparison with the \$500 billion that President-elect Biden is proposing to spend on his climate change legislation, says Wasserman-Drewes.

"This is not a handout from the government," says Jamie Powers, RIPE director of outreach. "It's payment for services rendered." •

Other Greenhouse Gases

Markets that sequester carbon dioxide are akin to a bright shiny penny that glistens at the bottom of a swimming pool. However, markets that mitigate less-discussed greenhouse gases like nitrous oxide and methane can garner more payoffs for farmers, says Debbie Reed, executive director of the Ecosystem Services Market Consortium (ESMC). ESMC partners with 61 private-sector companies and soil health and environmental groups to pilot projects that include water conservation and methods to sequester and mitigate greenhouse gas emissions.

"Emissions from nitrous oxide and methane are far more potent greenhouse gases than carbon dioxide," says Reed. Many methane emissions result from the making and use of fertilizer,

while livestock emit much methane gas.

Curbing these emissions, though, isn't as easy as planting a cover crop to sequester carbon dioxide. One promising avenue to slice methane emissions is through livestock feed additives, Reed says.

"These additives also tend to produce more protein per feed unit, so these can be a win-win," she says.

Systems, Not Practices
Payments based on a production system rather than a specific practice will

also better help garner goals like reduced greenhouse gases and improved water quality, Reed says.

"There are areas that are strapped for water, and it could be problematic if you plant a cover crop just for soil carbon [sequestration] and do not pay attention to lack of water," says Reed.

Systems approaches use a symbiotic suite of practices, such as a cover crop that fixes both nitrogen and also provides a high-quality forage for cattle in an integrated crop and livestock system, she says. •

300×

The amount of nitrous oxide per metric ton that is equivalent to 1 metric ton of carbon dioxide in terms of greenhouse gas emissions.

400×

The amount of methane per metric ton that is equivalent to 1 metric ton of carbon dioxide in terms of greenhouse gas emissions.

Source: Ecosystem Services Market Consortium

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LIVESTOCK'S ROLE IN A CHANGING CLIMATE

The grazing of livestock stores carbon in the soil.

By Raylene Nickel

Edward Bork's research surrounding how livestock grazing affects soil carbon has made him a believer in the beneficial role cattle can potentially play in a changing climate.

"Because their grazing contributes to the concentration of carbon in the soil – a helpful process – livestock can be a tool to help reduce atmospheric carbon and thus mitigate climate change," says Bork, director of the Rangeland Research Institute, University of Alberta.

Cattle critics say otherwise, calling for decreases in numbers or even elimination of ruminants as a means of reducing the greenhouse gases contributing to climate change. They point to the methane cattle emit as a key polluter of the atmosphere. Methane is a potent greenhouse gas that ruminants put out as part of their digestive process.

Bork calls for a balanced view, one that weighs the drawbacks against the benefits.

"Pointing the finger at methane emissions of livestock is a convenient excuse people use," he says. "It's a red herring to claim that cattle are destroying the planet and ignores

the fact that these grasslands evolved with grazing – and even depend on it to exist. Discussions of cattle and climate change should not talk solely about methane but should also include a full accounting of the role livestock play in storing carbon in the soil as well as in enhancing biodiversity."

Grazing Increases Carbon

The natural carbon cycle in soil begins as plants take in carbon dioxide (CO₂) from the air. Plants use the carbon to make roots, shoots, and leaves. With the help of soil microbes, plants then transfer carbon to the soil through roots and decomposing residue. The stable storage of this carbon below ground builds soil organic matter, and it reduces levels of atmospheric carbon. The process is called carbon sequestration.

While the carbon cycle occurs naturally with varying degrees of efficiency in croplands as well as in grasslands – with or without grazing – grazing at moderate levels tends to increase the amount of carbon sequestered in grassland soils.

Drawing from her research and the research of other scientists, North Dakota

Research shows that plants put more carbon below ground as a result of grazing livestock.

grassland ecologist and science application educator Rebecca Phillips says, "We are finding plants put more carbon below ground as a result of the grazing of livestock. A well-managed grazing system stores more carbon in the soil than grasslands that are not grazed.

"The key is the activity in the plant roots," she says. "Their response to grazing is to produce more roots and more exudates through the roots. Exudates feed the microbial population in the soil. In turn, microbes process the root materials, transforming them into forms used by microbes stored in soil – effectively improving the health of the soil to support plant growth. Grazing is one key to supporting healthy microbial communities in soil."

Phillips cites results of a study published in *Global Change Biology*, where the average mass of plant roots harvested from grazed grasslands was more than 2,400 pounds per acre. In comparable ungrazed grasslands, the average mass of plant roots was 740 pounds per acre.

The greater root mass produced in grazed grassland partially explains why grazing tends to concentrate more carbon in the soil.

Bork's research bears this out. He and his team measured soil carbon at more than 100 grassland sites spanning six distinct climate subregions in Alberta. Each site included an area of long-term grazing as well as one that was not grazed. ▶

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Rebecca Phillips is a grassland ecologist and science application educator based in North Dakota.

ing of the whole picture.”

She estimates, based on a study by Francis Kelliher and Harry Clark in 2010, enteric methane produced today on the Great Plains by 40 million cattle amounts to “13 pounds of carbon as methane per acre per year.” This amount is dwarfed by Bork’s and others’ measurements of total carbon stored in grassland soils – carbon that would be at risk of release back into the atmosphere if the grassland became cropland to produce plant-based protein.

The amount of methane emitted by cattle also needs to be balanced against the natural processes built into grassland ecosystems that scrub methane from the atmosphere. “Studies are showing grasslands can be a net sink for methane because there are microbes in the soil that break down methane,” Bork says. “Because of these little scrubbers, healthy grassland soils are able to offset a portion of the methane produced by cattle.”

The holistic circle of benefits grazers provide includes consumers. “Plants, grazers, and microbes all work together to build healthy soils while converting grass to a healthy source of protein for people,” Phillips says. **SF**

Learn More

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“We found moderate grazing enhanced soil organic carbon concentration by 12% in the upper 15 centimeters of soil,” Bork says. “Total carbon stocks – most of which was in the soil – within the grazed areas weighed from 20 tons per acre to 80 tons per acre.”

The wide, site-specific range in the levels of carbon potentially stored in soil as a result of grazing causes ranchers to wonder what level of carbon their systems are storing. Phillips says, “Increasing organic carbon from 3% to 4% in the top 4 inches of the soil profile is approximately equivalent to storing an additional 11 tons of carbon per acre.”

This gives producers a seat-of-the-pants yardstick of how much carbon regenerative grazing systems potentially draw out of the atmosphere. This, set against the backdrop of Bork’s measurement of vast stores of carbon stocks in grasslands, suggests the stakes are high in the debate over cattle’s role in climate change.

Movement of this large mass of sequestered carbon back into the atmosphere, as occurs under cultivation, could result from a swing in consumer demand away from beef and toward plant-based replacements. Economic-driven changes in land use could result, and the upshot could be significant new emissions of CO₂ from the soil back into the atmosphere. This CO₂ would contribute to global warming.

Ongoing land-use changes could intensify as ranchers are forced to convert grassland to cropland in an effort to replace income lost

from displaced beef sales. Conversion typically involves using chemicals to kill grass and may also include tillage to break up sod, in the process reducing biodiversity.

Much of North America’s “mixed-grass prairie should never have been plowed in the first place due to poor agronomic conditions,” Bork says. Original plowing of the prairie resulted in an explosion of stored CO₂ into the atmosphere. Some researchers estimate soils of the Great Plains region have lost as much 50% of their carbon-loaded topsoils after decades of farming.

“There’s a significant environmental penalty to pay,” Bork says. “Yet grassland is still being converted to cropland in western Canada and many other regions of the globe. This conversion results in a 30% to 50% loss in soil carbon, released as CO₂ into the atmosphere. Restoring soil carbon takes years.

“Everything is at stake when grassland is converted,” he says. “A broad suite of goods and services provided by grasslands to society at little cost is lost, and it’s much more than carbon sequestration. Grasslands provide water purification, flood mitigation through reduced runoff, and habitat for birds and wildlife.”

The Whole Picture

Public criticism of livestock because of methane emissions picks away at one piece of a much larger holistic puzzle. “It’s taking a very limited view of the carbon balance,” Phillips says. “There needs to be a greater understand-

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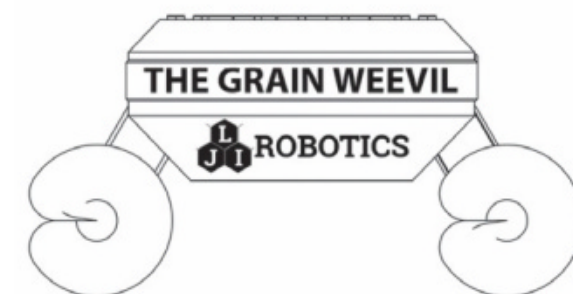
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GRAIN WEEVIL ROBOT

Technology keeps farmers out of grain bins.

By Laurie Bedord
Executive Editor, Ag Technology
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Zach Hunnicutt doesn't like going inside a dirty, hot grain bin, but he does – and quite often. At minimum, the Nebraska farmer enters 11 grain bins five times a year to manage stored grain.

“That’s at least 55 times a year our friend runs the risk of not coming out alive,” says Ben Johnson, an electrical engineering student at the University of Nebraska.

Hunnicutt isn't alone. Every year thousands of farmers and commercial grain handlers risk their lives by entering a grain bin to remove clumped or rotted grain. It takes about five seconds to become trapped in grain. After 22 seconds, a completely covered person has little hope of survival.

“Every time they breath in and breath out, that grain is going to get tighter, which means the next breath won't be as deep,” says Dan Neenan, director, National Education Center for Agricultural Safety.

From 2010 to 2019, 330 grain entrapments were reported in the United States, according to the 2019 Summary of U.S. Agricultural Confined Space Related Injuries and

Fatalities. While the numbers have gone down year over year, a recent uptick in documented cases is concerning. In 2019, there were 38 grain entrapments, an increase of eight from the previous year; 23 were fatal.

“Grain has to be managed throughout the entire storage process, and a farmer with a shovel has always been the best solution,” Johnson says.

Hunnicutt admits he is tired of scooping grain in a dangerous place. “I had a great-uncle die in a grain bin accident when I was young, so it has touched my family directly. My wife makes me check in every time I enter or exit a bin,” he says, adding his total storage capacity is about 500,000 bushels.

Send in the Robot

Aware that Johnson had a background in robotics, Hunnicutt asked the engineer to develop a product that would keep him out of the bin for good. The result is Grain Weevil – a robot that uses auger-based propulsion to move across the top of grain to address several safety issues including breaking up crusts, leveling bins, doing inspections, and helping with extractions so sweep augers work more efficiently.

“Basically, it reduces the viscosity of the grain, which allows gravity to do the rest of the work,” explains Johnson, chief innovation officer of JLI Robotics, a company he founded with his father, Chad Johnson.

Driven by a handheld remote, with plans to eventually run it autonomously, Grain Weevil can operate on one battery charge for about two hours. The company is also designing its robot to be linked in either a swarm of Grain Weevils or by attaching them to create one large robot for bigger tasks.

Grain Weevil weighs 26 pounds and comes in a backpack for safe carrying to the top of the bin. Other features include a swappable payload bay, expandable battery packs, a video stream, and a basic sensor package.

By spring, JLI Robotics' goal is to have a fully functional prototype, so it can begin on-farm trials and pilot projects. In early summer, it may also offer the robot as a service. The company is looking for farmers interested in providing feedback on Grain Weevil. Email Chad Johnson at chad@jlirobotics.com to learn more.

“We have created a robot that will fundamentally change how grain bins are managed,” Johnson says. “In the next five to seven years, we believe nearly every farmer will adopt some sort of grain bin robot.” **SF**



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ALFALFA TIPS FOR 2021

Take advantage of new genetics and rethink your harvest intervals.

By **Betsy Freese**, Executive Editor
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Headling into hay season 2021, there are a few trends that farmers should watch, says forage agronomist Dan Undersander, University of Wisconsin.

First, there are new races to some alfalfa diseases, such as anthracnose, and some alfalfa varieties have been developed with resistance to disease, says Undersander.

Second, aphanomyces root rot in alfalfa is getting worse, and some new resistant genetics are worthwhile, says Undersander. When he started research on aphanomyces more than 20 years ago, he focused on race 1. Now there are multiple races, with race 2 becoming more dominant and more virulent. Since race 2 resistance has been available, race 3 is becoming more of a problem. “New genetics is providing some resistance to the new races that are coming forward,” he adds.

The third trend is ever-increasing yields, says Undersander. He credits much of that to Roundup Ready and HarvXtra genetically engineered alfalfa. HarvXtra, by Forage Genetics International, was developed to maximize quality by reducing

the amount of lignin in the plant. It also includes the Roundup Ready technology for weed control. By using the HarvXtra trait and switching to a longer harvest interval, yields can go up about 20%, he says. “That’s a pretty big deal.”

New gene editing work with CRISPR technology is also taking place across the country. “Almost all of it is not to market,” says Undersander. “There’s a lot of germplasm that the companies have been slow to bring onto the market because in many parts of the world, those would require the same approval process as a GM trait.” That isn’t the case in the United States, but since alfalfa is exported around the world, the gene marker research is not always coming forward, he explains. He expects the main benefit from new gene editing research to be in improved disease resistance and increased yield.

Rethink Every Cutting At Bud Stage

Producers should also look closely at every field decision they make this year, he says. When you have longer harvest intervals, you build better plant condition, Undersander explains. “We’ve harvested at the bud stage

because that’s what we need for top-quality feed, but we know that has stressed the plant.”

He suggests going back to the old recommendation of 10% bloom at third cutting to rebuild stand condition. “A lot of farmers have forgotten about that. They take every cutting at the bud stage, and that tends to weaken the plant. It has the potential for greater winter kill, and we don’t get as much yield on first cutting the next spring as we might otherwise,” Undersander says.

A new alternative with HarvXtra is delaying harvest by seven to 10 days, from a 28-day to a 35-day interval with quality remaining similar to conventional varieties harvested at 28 days. The delayed harvest boosts rebuilding the carbohydrates in the root and rebuilding stand condition. “The shoots are more likely to survive a hard winter, and therefore yield more in the next year,” says Undersander.

Consider rethinking your 28-day cutting schedule, he says, if “you end up with two weeks of growing season left after the last cutting. If you can spread it out to a 35-day schedule, you can use a full growing season.”

Another advantage of the new genetics is that alfalfa doesn’t change in quality quite as fast. “So if it’s about ready to be cut, and then it starts to rain and you’re held up a week, it doesn’t hurt the quality as much as with a conventional variety,” he explains.



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Weather Issues

Changing weather patterns have been hard on alfalfa in a number of ways, says Undersander, and he expects that to continue this spring. In Wisconsin, for example, there have been more warm spells and then freeze backs during winter the past few years. “That’s been detrimental. It used to be cold and snow would stay there until it warmed up for good,” he says. “Now, we tend to have growth periods and freeze back. So that’s one of the reasons for needing more carbohydrates in the root so that the plant can start growing, freeze back, start over, and be in good health.”

In other parts of the country, generally warmer temperatures and drier conditions are affecting the health of alfalfa. “It has to be able to handle those circumstances consistently over several years, and that has been a challenge,” he says.

Feeding Trends

The dairy industry has increased use of corn silage vs. alfalfa, says Undersander. There is a milk component advantage to feeding more high-quality alfalfa, because it is highly digestible, but corn silage has had higher yield and is easier to produce. For one thing, corn is a single-harvest crop vs. alfalfa, which needs to be harvested multiple times.

“Nitrogen has been cheap, so the cost of the fertilizer isn’t as great as it used to be,” he explains. “There is no need for nitrogen fertilizer with alfalfa.” Also, alfalfa provides nitrogen for one to two years after plowdown.

If you feed a lot of corn silage, remember that the grain converts to propionic acid, and the rumen becomes acidic, warns Undersander. “If we feed alfalfa, the compounds are slowly released and we don’t get the acid buildup in the rumen that we do with a high corn silage ration,” he says.

When Buying Seed

Look for improved disease resistance in the varieties and consider the reduced lignin products. “Not only will it give you greater quality, but it will allow you to increase the yield of your alfalfa,” he says. The new technology in genetics offers three big things: quality, yield, and a little bit of insurance against Mother Nature.

New Tech in Genetics

Alfalfa genetic discoveries have sped up in the past decade, says Julie Ho, vice president of research for Forage Genetics International, mainly with the release of Roundup Ready alfalfa (fully deregulated in 2011) and HarvXtra alfalfa (2014). The Roundup Ready trait has enabled better stand establishment and weed control and, in turn, higher yield potential, feed quality, and persistence. The HarvXtra trait has delivered 15% to 20% improvements in forage quality (i.e., higher digestible fiber and reduced lignin content) compared with the cumulative 3% improvement over the 30 years prior.

By combining molecular and classical field breeding in the Midwest and Northeast, researchers have made improvements in disease and insect tolerance, including anthracnose, aphanomyces, and potato leafhopper, while continuing to make incremental improvements in winter survival and yield, says Ho.

“In the West and Plains, we’ve tackled challenges in water quality and availability by developing varieties with improved salinity and nematode tolerance. It’s truly been an exciting and productive decade.”

The most promising research for alfalfa today centers around farm productivity and land stewardship, says Ho. “The benefits of alfalfa to farm economics, whether hay grower or dairy producer, have not been communicated broadly enough to realize fully grower ROI.” **SF**



The Solar Power Bonanza

Farmers can readily tap into the explosive growth in solar generation.

By Dave Mowitz

Executive Editor, Machinery & Technology

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Sandy and Greg Brummond know a good deal when they see one. Five years ago they cashed in on incentives offered on solar systems and invested in a \$39,000 solar array that sits atop their farm shop near Craig, Nebraska.

The payoff was twofold for the Brummonds. Their current system (which can be expanded) generates 43% of the electricity their farm and home uses. Second, their solar array came with financial help. “To offset some of the cost, we got a \$9,000 federal grant,” Sandy Brummond explains. “We also qualified for a 30% federal tax credit that offset \$12,000 from the purchase and installation cost.”

The Brummonds’ experience confirms that farmers have a front-row seat in one of the hottest energy acts in the nation. Wind power is the current darling of the exploding alternative energy industry. That industry is dominated by utilities mining government incentives to install massive wind tower arrays, for which successful applications are geographically limited.

Unfettered by geographic restrictions, solar arrays can create electricity almost anywhere in the country. Furthermore, they are not restricted by size. Anyone with a south-facing roof or ample land can generate their own electricity, potentially selling excess generation to a utility (see “Getting Paid for Excess Electricity”).

Spurring investment in private systems are incentives that substantially offset the cost of buying a solar array (see “Mining Solar Incentives”). Those enticements have diminished slightly of late.

But Graham Christensen expects that the political bipartisan support solar energy enjoyed in the past along with a recommitment to incentive programs by the new administration will enhance funding in the near future.

Christensen knows firsthand the possibilities of solar for agriculture. His family farm near Lyons, Nebraska, invested in two solar arrays. One is a 5-kilowatt roof-mounted system and the other is a 20-kilowatt freestanding array. Combined, these arrays generate about 27,000 kilowatt hours (kwh) of electricity annually.

He also has a business developing and installing alternative energy projects for individuals, farms, municipalities, and large commercial ventures (often





Mining Solar Incentives

Many grants, loans, and tax credits are offered to offset the lion's share of solar array costs.

There are myriad financial incentives available that, if combined, can cover as much as 70% to 75% of the bill for investing in solar. These incentives do not include the electricity savings and potential utility company credit from farm generation (see “Getting Paid for Excess Electricity”).

Some of these incentives, such as the USDA's REAP grants and loans as well as federal tax credits, are applied nationwide. Other tax credits, property tax exemptions, and rebates vary by region and state. Following is a brief explanation of these incentives.

► **USDA REAP.** The Rural Energy for America Program (REAP) provides financial assistance to purchase, install, and construct renewable energy systems for up to 22% of a solar project's cost. REAP loans can cover up to 75% of the cost of a project. The combined amount of a REAP grant and loan guarantee must be at least \$5,000 (with the grant portion at least \$1,500) and may not exceed 75% of the project's cost.

Warning: The 100-plus-page application and process are extensive, says Rory Piermattei, a loan specialist with the

Pennsylvania USDA REAP program. “But a guaranteed REAP loan makes your banker sleep better at night, so it's worth the time and effort to apply,” he says.

Many state USDA REAP and energy offices offer help in applying for a grant or loan (go to rd.usda.gov/files/RBS_StateEnergyCoordinators.pdf). You also can hire a grant writer familiar with the program to assist in completing an application. Grant writers will conduct a prereview scorecard of your system, which can save time in your application, points out Sarah Conley-Ballew of Rural Action's Sustainable Energy Solutions program (ruralaction.org).

Deadlines for REAP applications are March 31 and November 2. For more information, go to rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency.

► **State alternative energy loan programs.** Your state may also offer zero- or low-interest loans for the development of alternative energy production projects. For example, Iowa offers an alternative energy revolving loan program that provides a minimum amount of \$25,000 and maximum amount of \$1 million to cover up to 50% of eligible project costs. Contact your state's energy office for more information.

► **Federal Solar Investment Tax Credit (ITC).** This credit allows you to deduct up to 22% of your project's cost from your

federal taxes. If you don't have enough tax liability to claim the entire credit in a single year, you can carry the remainder over the following 20 years.

► **State-based tax credit.** This tax credit varies widely by state. For example, Iowa has a solar tax credit of 15% of the cost of a project (\$5,000 limit). Remaining credit can be carried over for up to 10 years.

► **Accelerated depreciation.** The Modified Accelerated Cost Recovery System (MACRS) allows farm businesses to deduct 85% of the value of qualified solar equipment over a five-year period. Talk to your accountant about MACRS and find additional information at seia.org/initiatives/depreciation-solar-energy-property-macrs.

► **Property tax exemption.** Installing solar panels increases your property's value, but some states offer an exemption for solar systems. For example, Iowa offers a 100% property tax exemption for five years.

► **Solar energy sales tax exemption.** Again, depending on your state, you may be exempt from paying sales tax on solar system equipment; have your accountant check.

Finally, some states, municipalities, and utility companies offer incentives in the form of rebates and equipment discounts. •

involving power utility firms).

Financial incentives have been reduced recently, Christensen says, “but they can still contribute a substantial amount to the investment costs in a system. And I expect the growth of alternative energy, and especially solar energy, is going to be explosive in the future, which will lower costs further.”

Costs have already fallen. Solar components pricing is down more than 80% during the past seven years, according to the National Rural Electric Cooperative Association.

Christensen sees an even wider margin of cash flow

potential for solar systems. He also predicts the possible emergence of a trend for farms to become energy producers working in cooperation with local utility providers.

“From a national-security perspective, having more localized and widely dispersed systems of energy generation makes sense,” Christensen adds.

The Solar Electric Investment Analysis Series, a comprehensive guide on investing in solar generation written by Eric Romich of Ohio State University and F. John Hay of University of Nebraska-Lincoln, can be accessed at projects.sare.org/information-product/solar-electric-investment-analysis-series-2/. • ►

Solar-Powered Shop

Sandy and Greg Brummond's 34-panel solar array rests atop the south side of their shop's 30×50-foot roof, generating up to 10 kilowatts of power for their 2,500-acre operation. "The roof has about a 6-to-1 pitch," Greg explains, adding that this is enough to prevent snow from collecting on the roof and interfering with the panels. Fixing the panels on the roof offered aesthetic and logistical benefits for the Brummonds. "We like the look of the array on the roof," Sandy says. "It doesn't take up space in our yard, and we don't have to mow around it like we would if the array was freestanding."

The 10-kilowatt system produced about 13,000 kwh of electricity in 2019. "That's about 43% of the electrical energy we used on our farm and in our home last year," Greg explains. "Our shop draws the most electrical energy on the farm."

When they installed it in 2015, the cost of the system was \$39,000. "We went with U.S.-made solar panels, which we understand are more expensive. And we had the electrical components sized so that we can eventually expand to a 20-kilowatt system," Greg says. Net metering provided by their power supplier, Burt County Public Power District in Nebraska, gives the Brummonds credit on the energy they generate. The net difference between how much energy flows back on the utility's system or flows to their farm from the utility is credited or billed to the Brummonds. •

What Size Solar System?

Answer: It depends.

Determining the right size for your property starts with digging out your last 12 months of power bills. The aim of this accounting is to establish average monthly and annual consumption used in calculating:

- ▶ **Total annual kwh**
- ▶ **Average monthly kwh**
- ▶ **Seasonal kwh (winter vs. summer, for example)**

These figures provide baseline estimates that help in deciding how much power you want to derive from a solar array.

Other factors to consider in establishing the ultimate size of a solar system include:

- ▶ **How much money can you afford to invest?**
- ▶ **How much space (roof or land) is available to accommodate the array?**
- ▶ **Does your utility provider have capacity limits restricting system size?**
- ▶ **What are future expansion plans for the farm that would increase electricity consumption?**
- ▶ **Is your electric usage fairly consistent or variable?**

A guide to sizing arrays, "Estimating the Size of Your Solar Electric System," can be found at energizeohio.osu.edu. •

Getting Paid for Excess Electricity

On the surface, net excess generation (NEG), also known as net metering, seems simple. Electricity generated by a solar array not used on the farm flows into the power grid to earn credit. "Each electric bill will indicate the net amount of electricity for that billing period (electricity used and produced)," explains F. John Hay of the University of Nebraska-Lincoln. "If there is net excess generation, the utility will apply a credit (in kilowatts or dollars) to the electric bill to offset charges in future months."

How much credit you receive, however, varies greatly by your location.

For example, private (not public) utilities in Iowa must provide customers with net metering where 100% of the excess electricity a farm system generates receives a 100% credit at retail rates to offset future electric costs.

Just 29 states require such full retail net metering while other states require utilities to compensate customers at an "avoided" cost rate (which can be substantially lower than full retail rate). South Dakota and Tennessee do not have any form of net metering.

You can discover your state's NEG policy in the Solar Net Metering Guide on the Solaris Technology blog. •

Solar Array Building Blocks

Solar systems can vary in size from single-kilowatt panels to mega-kilowatt arrays. Regardless of size, a system's basic components remain the same and include:

▶ **Solar panels.** Also called modules, these consist of a series of photovoltaic crystalline silicon cells wired together in a series, encapsulated under tempered glass, and surrounded by a steel or aluminum frame. Panel output is given in watts. "Panels are warrantied for 25 years [an industry standard] but can produce electricity

longer than that," notes Autumn Long of Solar United Neighbors (solarunitedneighbors.org).

"Maintenance is low since there are really no moving parts. In most parts of the country rainfall is enough to keep the surface of the panels clean. And the sun is enough to melt all but excessive snowfalls." Production does slowly degrade over time but often less than 0.5% a year.

▶ **Racks and pedestals.** Racks are often made of aluminum while pedestals are steel. The panel mounts can be installed on a roof or the ground and are either fixed (panels are preset for height and angle and don't

move) or track. Tracking arrays automatically adjust their angle to maintain optimal exposure to the sun.

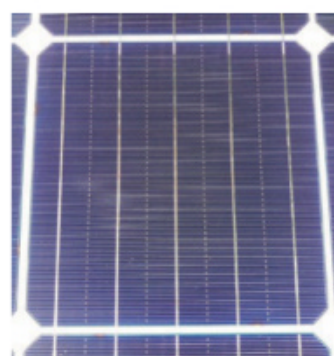
▶ **Inverter.** This device converts the direct current (DC) generated by solar panels into alternating current (AC). Inverters are warrantied for 10 to 25 years depending on their type.

▶ **Meter.** Some utilities require the installation of a meter that runs both forward and backward to account for the current consumed or generated by an array. Other utilities require two separate meters – one for

incoming power and another accounting for electricity that goes

into the grid. "Some rural utilities may require insurance policies before they will grid-tie a system," says Eric Romich of the Ohio State University. Meters are sometimes paid for by the utility company but are more often paid for by the farmer. "Publicly owned utilities may charge as much as \$1,000 to replace a one-way with a two-way meter," Romich adds.

▶ **Battery backup.** Backup battery systems are offered in flooded lead-acid (FLA), sealed absorbed glass mat (AGM), and sealed gel cell design. Flooded lead-acid batteries offer the lowest cost per amp-hour of storage and have the longest life (often as long as 10 years). However, FLAs do require more maintenance. •



Closeup of a common monocrystalline solar panel.

Possibilities, Perils of Solar Leases

Rapidly expanding interest in solar is presenting farmers with an opportunity for long-term leases. While these are attractive, farmers considering such long-term leases may take ground out of production for decades. “These sorts of contracts require careful consideration,” urges Todd Janzen of Janzen Ag Law (aglaw.us). When considering a long-term lease, he advises getting the help of an attorney and weighing these questions.

► **Is the developer paying enough to close the door on competitors?** A solar lease (also called an easement) will likely tie up property for a period of years while the developer arranges permits, funding, and other items necessary for construction. Provided the farmer can continue farming the land, little rent during this period is probably OK, Janzen says, “but consider, too, that the farmland will be taken off the solar leasing market during this period.”

► **Do the lease payments account for inflation?** A long-term lease should have a built-in rent payment escalator based on the consumer price index (CPI), a regularly posted inflation rate, or a negotiated percentage annual increase.

► **Who gets the carbon and tax credits?** Likely the solar company will take the credits. “But understand, you may be giving up an enormous upside if these markets take off years from now and companies are willing to pay farmers to sequester carbon as part of their farming activities,” Janzen says.

► **Will the developer keep land maintained to your standards?** “A field of solar panels seems harmless enough, but what happens if the field is full of noxious weeds that spread onto neighboring fields?” Janzen questions.

► **Will the developer provide a removal bond?** The lease should spell out the consequences if the solar company goes out of business and leaves a field full of solar panels. “A farmer should insist that the developer provide some form of security that will pay for the cost of removal if the solar company goes bankrupt or disappears. This is a must,” Janzen says. •

Bright Future in Store for Farm Solar

Farming has a culture of independence, observes Graham Christensen, who farms with his father, Fred, and brother, Brad, near Lyons, Nebraska.

“Farmers are interested in energy independence, and investing in solar is an investment that potentially brings money back to the farm,” he says.

Christensen knows of what he speaks. His family’s farmstead is powered by two solar arrays. One is a 5-kilowatt roof-mounted system while the other is a 20-kilowatt free-standing array.

Combined, the two arrays generate 27,000 kwh annually that “offsets

59% of our farm’s total energy draw,” Christensen says.

The estimated cost of installing a 25-kilowatt system would be approximately \$62,500 before tax credits and other financial incentives are deducted, he figures. Given the fact that a solar array enjoys a 25-year life span, the amortized cost of that investment would be \$2,500 a year. Dividing that annual cost by 27,000 kwh of electricity generated annually yields a power cost of 9¢ per kwh, Christensen calculates.

But capitalizing on solar incentives to install such an array would drop that cost to 7¢ per kwh. “You can readily see the payoff for farmers,” Christiansen adds. •

Farming Under Solar Panels

Solar panels don’t have to take land out of production.

A decade-long research project by the University of Massachusetts evaluated a solar array consisting of three panels vertically stacked and elevated by a racking design that supports the panels 4 to 7 feet off the ground.

The panel clusters were spaced to 2 to 5 feet apart, permitting sunlight to reach grass growing beneath the panels. “Every spot beneath the panels gets about two-thirds of the full amount of sunlight throughout the day,” explains university agronomist Stephen Herbert of the project’s 17-kilowatt installation.

A similar elevated panel cluster is in commercial



product from Hyperion Systems (hyperionsystemsllc.com). Costs of elevated solar arrays vary widely, ranging from \$2 to \$5 per watt.

“The area underneath the panels produced 90% to 95% of the yield of the pasture area not covered by solar panels,” Herbert says. “Also, on hot summer days cattle can lie down in the shade underneath the panels.”

Research results suggest that growing crops and generating energy make good partners.

“If farmers are planning on installing solar panels or are approached by a solar company hoping to develop their land into a solar farm, they should do it in such a way that they can keep agriculture going on the land,” Herbert adds. “They can continue to earn an income from farming in addition to the revenue earned from solar energy.”

The Massachusetts project is also researching producing vegetables and other crops under the panel array. **SF**



SULFUR SURPRISE

Sulfur applications can trigger double-digit soybean yield increases, but responses hinge on factors such as planting date and soil type.

By **Gil Gullickson**
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If soybeans could talk, they'd tell you anti-pollution legislation works.

These laws – first passed in the 1970s – squelched sulfur-containing acid rain fueled by industrial emissions. Applications of fertilizer containing sulfur (S) previously benefited only crops grown on sandy soils, as atmospheric S would leach through them.

No more. “Sulfur responsiveness has occurred particularly more on the corn side, but we have also documented some pretty strong sulfur responses on soybeans,” says Shaun Casteel, a Purdue University Extension soybean agronomist. Running parallel to less “free” atmospheric S is increased S consumption by crops due to higher yields gleaned by farmers, he adds.

Purdue studies show S applications spike soybean yields 10 to 15 bushels per acre on sandy or coarse-texture soils with less than 2% organic matter. Applications of S also spur a 4- to 6-bushel-per-acre response on heavier soils with 2.5% to 3% organic matter.

Situational Sulfur Deficiencies

More eye-opening are responses on heavier soils with 3.5% organic matter or higher. Casteel describes these as “situational sulfur deficiencies.”

“Those soils have plenty of organic matter that mineralizes and provides both sulfur and nitrogen to crops,” says Casteel. “In those soils, we’re seeing double-digit [bushel-per-acre] yield increases with some of these sulfur treatments. The plant response is visually striking in the middle of the season. They’re green as a gourd vs. the highlighter green [of S-deficient plants].”

These yield perks are linked to earlier Midwestern planting of soybeans in late April or early May, says Casteel. Heavier soils high in organic matter tend to be cooler and wetter during this time. This limits mineralization, which squelches sulfur supplied by the soil. Also accentuating S responses is heavy residue keyed by reduced tillage or cover crops, he adds.

“In conventional tillage, you get a little more release [of sulfur] from the organic matter, but you don’t get that with no-till and strip-till,” says Paul Groneberg, a retired

Shaun Casteel, Purdue University Extension soybean agronomist, says sulfur responses have even occurred in soils with organic matter levels 3.5% and above.

Central Crop Consulting agronomist based in west-central Minnesota. “Sulfur is a key element [to add] in those strip-till and no-till situations.”

Later planting, though, erases the merits of S applications on these soils.

“These same sulfur treatments applied to soybeans planted during the first week of June have no response,” he adds. The warmer soils lead to more mineralization of organic matter, which translates into more soil S, he adds.

Form and Application

Normally, a yield spike of 2 bushels per acre is needed to cover product and application costs. “This can fluctuate depending on market prices and product costs, but it’s been a fairly consistent number,” Casteel says.

When to apply S is often the larger issue.

“To get the most bang for the buck, you need to apply it in early [soybean growth] stages, from planting to V2 or V3,” says Casteel.

Twenty pounds of S applied in the form of ammonium sulfate (AMS) close to planting or during early vegetative growth is a good starting point, he observes. Granular AMS is the most straightforward form, but farmers can apply granular S in other ways, such as a 50-50 mix ▶

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The appearance of soybeans receiving no sulfur fertilizer (left) reveals a thinner canopy compared with soybeans (right) that received 20 pounds of sulfur per acre.



between granular AMS and elemental sulfur.

Farmers may also mix liquid S formulations with starters like 10-34-0. Applications of ammonium thiosulfate (ATS) and potassium thiosulfate (KTS) in a 2-inch offset dribble on top of the soil surface is another starter option.

The drawback is that not every farmer is set up for such starter applications.

“Most who do so are planting in 30-inch rows,” says Casteel. “So, we lose out on some of the potential yield increase with wider rows. That puts us between a rock and a hard place.”

Other application options include applying granular AMS with a fertilizer rig to soybeans up to the V3 stage. Soybeans flattened by tires can still bounce back at this stage. After that stage, flattened plants with no extra yield potential result.

Foliar S applications haven’t worked as well as granular S applications in Purdue trials, due to phytotoxicity issues. Antagonism can also result when an S form like ATS is teamed with a burndown or preemergence herbicide.

There may be potential, though, when liquid S formulations are teamed with fungicide and/or insecticide applications during reproductive soybean stages.

“There are some intense management synergies that first need to be

understood,” Casteel says.

Excessive S can be detrimental, particularly on late-planted soybeans. “We saw that in 2019, when 20 pounds [per acre] of sulfur in a concentrated band with starter ATS restricted plant development,” says Casteel. “I think the high rate was burning roots and thereby suspending nodulation and nitrogen fixation. We ended up having shorter plants and taking a yield hit, compared with no or lower rates of sulfur.”

What to Do

Unless S can be applied at planting as a starter, broadcasting S requires another field trip. This costs time and money and can delay planting.

“I would rather have growers plant timely when fields are fit, and then come back with the sulfur application,” Casteel says.

Yield responses also may vary, even on S-deficient soils. “In 2019, responses were not as high as in other years, even on normally responsive sites,” he reports.

Reference strips to which no S is applied and in-season tissue tests can gauge S application effectiveness. This information can help farmers determine which fields are most likely to show an S response in future years.

“These huge responses do not occur on every field and in every situation,” Casteel points out. “But these responses are happening with enough frequency that they should be considered, especially for those who are pushing planting dates and higher yields.” **SF**

Nitrogen Boost

Sulfur starter or broadcast fertilizers that also contain nitrogen (N) may also garner an additional yield response due to the inclusion of N.

“We don’t see it every year, but there can be a benefit from the nitrogen in a product like AMS [ammonium sulfate] or ATS [ammonium thiosulfate],” says Shaun Casteel, Purdue University Extension soybean agronomist. “You won’t have that with calcium sulfate or gypsum. The nitrogen helps stimulate plant growth, especially in cooler and wetter fields. The sulfur is a cofactor for nodulation and nitrogen fixation.” •

How Soybeans Consume Sulfur

Crops can no longer rely on atmospheric sulfur (S) to meet crop S needs.

“We no longer receive 15 to 20 pounds [per acre] annually of sulfur from atmospheric deposition,” says Shawn Casteel, a Purdue University Extension soybean agronomist. “We’re at 5 pounds [per acre] or less across the Midwest.”

Here’s a hypothetical example from Mosaic about how much sulfur soybeans consume, their natural S sources, and how much S fertilizer is required.

Soybeans

Yield: 60 bushels per acre

S uptake: 17 pounds per acre

S atmospheric deposition credit: 6 pounds per acre

S organic matter contribution: 5 pounds of S per acre (1% organic matter = 2.5 pounds per acre)

S deficit: 6 pounds per acre

Suggested S application rate: 10 pounds per acre (based on 60% efficiency rate) •



6 STEPS TO HALT HERBICIDE-RESISTANT WEEDS

Preemergence products are critical to nix these invaders before they start.

By **Gil Gullickson**
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Two years ago, Bruce Stripling sat in FMC's booth at the Commodity Classic trade show, viewing companies pitching the latest agricultural technology.

"All this technology, and here we are, still pulling pigweeds," says the regional technical service manager for FMC.

Stripling hails from Georgia, where Palmer amaranth started to devastate soybean and cotton fields in the mid-2000s. At that time, glyphosate-tolerant Roundup Ready technology still worked well in the Midwest.

Before Roundup Ready, Georgia farmers managed weeds in cotton and soybeans with a mix of tillage and overlapping residual herbicides.

"Roundup Ready was one of the biggest technologies since the Green Revolution, but it did have one bad side effect," says Stripling. "It made us lazy."

Bit by bit, weeds like glyphosate-resistant Palmer amaranth and marehail escaped. Georgia farmers dealt with it by a mix of tillage, overlapping residual herbicides, and postemergence herbicides used in other herbicide-tolerant systems. In extreme cases, they hired weeding crews who pulled Palmer amaranth plants and loaded them in a wagon to destroy outside the field. (Palmer amaranth can reroot itself if tossed aside.)

Paging Jimmy Durante

In a sense, herbicide resistance is akin to the trademark line of the late comedian Jimmy Durante: "Everybody wants ta get inta da act!"

A clean soybean field in August starts with a weed management plan that includes preemergence residual herbicides and multiple effective herbicide sites of action.

Following this situation faced by Georgia farmers, Midwestern farmers soon struggled with glyphosate-resistant weeds. "Mother Nature always wins," says Stripling.

That's a point to consider when forming weed management plans for 2021 and beyond. Farmers have a host of preemergence and postemergence herbicide options to consider. Still, using the same herbicide strategy year after year will trigger what happened with glyphosate-resistant weeds.

"We now have [herbicide-tolerant postemergence] dicamba, glufosinate, and 2,4-D-choline technologies," he says. A key to keeping ▶

these technologies effective involves steps like including overlapping residual herbicides in tank mixes, he adds.

“Without such steps, we will see them fall to the same circumstances that eroded glyphosate in post applications,” says Stripling. “Whatever comes in the marketplace will not last forever.”

What to Do

Here’s a list of recommendations on how farmers can forestall herbicide resistance with those technologies and improve weed control.

1. Don’t use just one herbicide program. So far, the only weed that resists glufosinate – used in several postemergence herbicide-tolerant systems – is Italian ryegrass that surfaced in Oregon and California orchards and vineyards. That doesn’t mean glufosinate is immune to resistance in row-crop production, says Mark Storr, BASF technical services representative.

“Certainly, we don’t want to use Liberty [glufosinate] followed by Liberty followed by Liberty,” he says. Instead, farmers should aim to apply such products in tank mixes incorporating different effective herbicide sites of action and also use preemergence chemistry, he adds.

2. Nix early-emerging weeds with preemergence herbicides. Ever get a bit grumpy when you get a fertilizer bill? This minor annoyance could morph into ear-steaming anger at the thought of 1- to 2-inch-high weeds consuming up to 9 pounds per acre of nitrogen.

“This also reaches into other nutrients, like P and K and micronutrients,” says Mark Kitt, Syngenta herbicide technical product lead. Ditto for the inch of water that 3-inch-high weeds can remove from the soil in three days, he adds. “It’s important to use broad-spectrum preemergence residual herbicides to control weeds before they emerge,” he says.

“One of the best recommendations is the old adage of start clean, stay clean,” says Randy Niver, a DeKalb/Asgrow agronomist. “Let’s think about adding one more phrase: ‘Start clean, spray clean, stay clean.’ If we can overlap residual herbicides, we can keep weeds from emerging and never see a weed in the field.”

Preemergence residual herbicides aren’t bulletproof, though.



Mark Storr



Aaron Hager

“Depending on the product, you can expect the residual to last from 10 days to two weeks up to maybe more than a month,” says Meaghan Anderson, an Iowa State University Extension agronomist.

About ½ inch of precipitation is also needed for activation, she adds. If rainfall is not received, weeds can shoot past early-growth stages to the point where they’re more difficult to control with postemergence herbicides.

The alternative of relying solely on postemergence soybean herbicides is not a good one, though. “You are putting weed control at risk because you have fewer options,” she says.

3. Don’t be penny-wise and pound-foolish when it comes to weed management.

“In a year when everyone wants to cut costs, it’s tempting to cut out a residual preemergence herbicide,” says Aaron Hager, University of Illinois Extension weed specialist. “That is a terrible mistake.”

Without a residual herbicide, numerous weed seeds are exposed to post-emergence herbicides like glufosinate, dicamba, glyphosate, and 2,4-D choline. A herbicide selects for resistant weeds during each application.

“Having more weeds only speeds it up,” says Hager.

4. Tank mix effective multiple herbicide sites of action. Applying several herbicides with a different site of action in a tank mix is less likely to result in weed resistance than applying different

Dicamba Moves Forward

The Environmental Protection Agency (EPA) in October approved the use of dicamba formulations for dicamba-tolerant soybeans and cotton for the 2021 to 2025 growing seasons.

Approved herbicides include Engenia (BASF), Tavium Plus VaporGrip Technology (Syngenta), and XtendiMax with VaporGrip Technology (Bayer Crop Science). Bayer is the registrant for the dicamba formulation that Corteva Agriscience previously marketed as DuPont FeXapan herbicide with VaporGrip. At presstime, Corteva had applied for federal registration of FeXapan.

Changes from previous registrations include:

- A national cutoff date of June 30 on soybeans. This differs from the 2018 label that prohibited over-the-top (OTT) application of dicamba on soybeans 45 days after planting.

Slight differences exist in cutoff wording between chemistries. Bob Hartzler, Iowa State University Extension weed specialist, says XtendiMax application is prohibited after R1, even before the June 30 cutoff date. If the R1 stage has not been reached, XtendiMax can be applied up to June 30. Tavium application is allowed through V4, but not after June 30, he says.

There is no mention of growth stage with Engenia, Hartzler says. This may enable Engenia to be applied later than XtendiMax in some cases, but not after June 30, he says.

- Mandated use of a pH buffering agent in all dicamba formulations applied to dicamba-tolerant crops. Adjuvants like these reduce acid content of tank mixes by pushing pH above 5 [acid content increases as a solution moves downward on the 0-to-14 pH scale]. The higher the acid content, the more prone a herbicide is to volatilize and move off target.

- Increased the required downwind buffer from 110 feet to 240 feet, with an increased buffer of 310 feet in counties where endangered species exist.

States may be able to enact additional regulations, but will first need to work with EPA, says Alex Zenteno, Bayer dicamba product manager. •

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Farmer Greg Dieckmann from Levasy, Missouri, was one of several participants in the XtendFlex soybeans trial that evaluated the next generation of Roundup Ready® Technology.

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"Dicamba is a great product, and we've had good luck with it," Dieckmann says. "The Liberty herbicide tolerance gives us another option, and it has worked very well for us this season."



Greg Dieckmann
MISSOURI SOYBEAN FARMER

Dieckmann grows corn and soybeans and manages a cow-calf herd on the farm that was first cultivated by his grandparents and father. Since the early 1990s, he's been farming Jackson County's rolling hills and Missouri River bottoms. This year, Dieckmann planted just over 400 acres with XtendFlex soybeans products.

"I plan to use XtendFlex soybeans next year and they very likely will be in 100% of my acres," he says. "I'm doing that for high yield potential and the variety of weed control options that XtendFlex soybeans give me."

Introducing a new line of seed technology is a multiyear process. The last growing season before the soybeans are commercially available helps confirm new products like XtendFlex soybeans perform the way they're intended. Bayer has made a substantial investment in the XtendFlex soybeans portfolio to deliver both strong agronomic performance and high yield potential in all maturities.

"This new technology is at least as big of a step forward as the Roundup Ready 2 Xtend soybeans were in their day."

"I would recommend XtendFlex soybeans to my neighbors because of the flexibility they provide and the ability to take care of the very tough-to-control weeds we have in this area," Dieckmann says.

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Waterhemp seed is small, shiny, and black.

Know Your Waterhemp

Waterhemp double-teams farmers who battle it. That's because this pugnacious pigweed is dioecious, meaning there are male and female plants that team up to inflict misery upon farmers. Males provide the pollen, while females produce the seed that can tally around 500,000 seeds per plant. Farmers who rogue a few stray waterhemp plants before harvest should target their efforts toward seed-bearing females. Although male and female differences can be difficult to discern early in the year, they appear later in the season.

"Females are usually highly branched, whereas the males have fewer branches and the individual stems are longer," says Meaghan Anderson, Iowa State University Extension agronomist. "Male flowers are also quite a bit bigger."

Seeds can also be gleaned from female plants later in the season. "If you rub a male plant's head, you may get some anthers and other male flower parts," she says. "Tiny black seed will appear when you rub the heads of female plants." •

sites of action between years, says Hager.

In 2015, USDA-ARS and University of Illinois weed scientists released a study that found fields in which 2.5 herbicide sites of action per application were applied were 83 times less likely to select for glyphosate-resistant waterhemp within four to six years compared with fields in which only 1.5 herbicide sites of action per application were used.

However, the researchers stressed this works only if each component of the tank mix is effective against the target species. They also emphasized that effective, long-term weed management will require even more diverse management practices.

5. When in doubt, opt for a premix or branded product. These days, farmer-applicators are donning the equivalent of a chef's hat as they mix complex combinations of chemicals, adjuvants, pH modifiers, and other spray mix components. Forty-two components are used in Syngenta's Acuron herbicide, says Kitt.

"Developing a high-quality premix formulation is a complicated process," he says.

Farmers who form complex herbicide combinations on their own can save money, but it also increases risk. Crop injury can accompany improperly mixed combinations, says Kitt.

"Sometimes, components may not play

well together in the tank, and crop injury will occur," he adds. "We've also seen some generic companies that make a premix similar to one of ours, but have a reduced active ingredient." This can lead to less effective weed control, Kitt adds.

6. Use nonchemical weed techniques.

"A great man once said, you can't solve problems created with a herbicide by using another herbicide," says Richard Zollinger, northwest product development manager for AMVAC.

Cultural weed practices like narrow rows and cover crops can help squelch weeds before they start, says Wen Carter, AMVAC southern region technical service manager.

Ditto for harvest weed seed control (HWSC) strategies pioneered in Australia that include combines that grind weed seed at harvest. Another technique funnels harvest residue containing weed seed into narrow windrows at harvest. Farmers can then burn it, spray it, or leave it to rot.

By reducing weed seed numbers, Australian farmers increase herbicide effectiveness on surviving weeds. Weed scientists at several land-grant universities are testing that adaptation of these techniques for U.S. farmers.

There's a hitch, though.

"Steps like investing in a Harrington Seed

Destructor (a combine weed seed grinder) or a cover crop plan or implementing multiple strategies may cost more money up-front," says Carter, "but they may prevent farmers from being out of weed control options five years down the road." 



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IT STARTS WITH THE SEED

Sound soybean variety selection sets the stage for other yield-enhancing factors.

By Gil Gullickson
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Bill Backhaus leads off every agronomy training session he conducts with this question: “What’s the most important factor in soybean production?”

“Everybody has their own opinion, and I get a lot of different answers,” says the BASF seed agronomist. “Some say weed control. Others will bring up row spacing or diseases. But at the end of the day, the most important thing is variety selection and genetic potential.”

Other factors are important, but genetic yield potential lies at the core, he says. An average difference of 12.1 bushels per acre between the highest- and lowest-yielding soybean variety surfaced in 2014 to 2020 Iowa Crop Performance Tests conducted by the Iowa Crop Improvement Association and Iowa State University, Backhaus adds.

“We have to get out of the fallacy of selecting varieties first based on weed control and herbicide-tolerant traits,” Backhaus says. Excellent herbicide-tolerant trait technologies exist, but farmers should first

focus on genetics and agronomics when selecting varieties, he says.

Maturity Groups

One quandary farmers face when selecting soybean varieties is which maturity group to choose. On average, longer-maturing soybean varieties have potential – but no guarantee – to yield more than shorter-maturing ones, says Shawn Conley, University of Wisconsin Extension agronomist. In any given year, though, soybean yields between varieties with one maturity group (MG) difference – such as between MG 1.5 and MG 2.5 – can yield the same, he adds.

Kelly Garrett has followed this lead in backing away from planting MG 3.0 beans that he used to plant where he farms near Arion in west-central Iowa. He planted MG 1.7 to 2.7 soybeans in 2020 with no decreased yield potential.

“Last year, the MG 1.7 beans actually yielded the best,” he says. “I plan to plant some MG 1.4 beans this year.”

He also teams earlier-maturing soybeans with early planting, which started April 8

Maturing soybeans are the culmination of seed choices made before planting season.

in 2020. “Planting early beans gives a great opportunity to build a bigger [photosynthesis] factory,” he says. Ultimately, increased photosynthesis translates into higher yields, he says.

There’s also a marketing reason for planting early soybeans.

“I harvest early in September and get a basis opportunity,” says Garrett. “Last year, it was a 30 to 50 cents [per bushel] above basis when I harvested, and two weeks later it was 50 cents under. There are also no lines in the elevator.”

Early harvest also enables Garrett to plant winter wheat on a share of those soybean acres following harvest. It also means he harvests in better weather, rather than fight colder and often rainier weather later in the fall.

“Every day spent harvesting in September is worth two days in November,” he says.

Iron Deficiency Chlorosis

Pairing genetic potential with defensive characteristics is paramount. Those qualities are needed to tackle maladies such as iron chlorosis, which particularly plagues farmers in the Upper Midwest. High-yielding varieties susceptible to iron deficiency chlorosis (IDC) are riddled with the malady’s calling card of chlorotic leaves and stunted plants.

“It not only hampers



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Bill Backhaus, BASF seed agronomist, says that variety selection is the most important decision soybean farmers make each year.

Soybean Gall Midge Stalks Soybeans

A pest recently surfaced to torment soybean farmers. The soybean gall midge has been damaging soybeans in areas of Nebraska, Iowa, and South Dakota. Midge larvae feed inside the plant tissue and weaken plants.

“We see some issues in September with standability or lodging,” says Tammy Ott, a Channel technical agronomist. The good news is that so far, most feeding is limited to the edge of fields, with damage decreasing inside the field.

Entomologists are studying the merits of insecticide application and planting date, says Ott. There may also be a varietal solution on the way.

BASF is evaluating current and future lines for natural soybean gall midge tolerance. In one location near Griswold, Iowa, BASF tested 31 varieties ranging in relative maturity groups from 1.4 to 3.9. Each variety was replicated 14 times, and one variety showed increased native tolerance to soybean gall midge in each replication, says Bill Backhaus, BASF seed agronomist. However, more trials will be needed to further test potential varietal tolerance, he adds. •



Soybean gall midge larvae attack the inside of soybean plant stems.

yield, but it can also delay soybean canopy,” says Steve Carlsen, Levesol and crop enhancement manager for CHS Agronomy. “IDC delayed canopy can create some of the worst weed scenarios in those iron chlorosis fields.”

In west-central Minnesota, farmers were ready to scuttle soybeans and plant more corn due to IDC. That’s changed, says Harmon Wilts, a DeKalb/Asgrow technical agronomist. “We now have some varieties that can better tolerate iron chlorosis,” he says.

Variety selection, though, is just one way to manage IDC. Drainage is another.

“We tend to have high pH soils and high carbonates that contribute to iron chlorosis, and you can’t do much about them,” says Wilts. “The third factor is high salt content in our soils. If we install tile that doesn’t let the water table rise and bring all the salts with it, it decreases the incidence of iron chlorosis.”

Another tool farmers use to help manage IDC are iron chelate fertilizers – such as Soygreen – applied in the form of seed-placed and in-furrow treatments. They enable plants to take up iron from the soil to overcome iron chlorosis, Carlsen says.

Such treatments have a proven track record, says Carlsen. However, they can range in cost from the low \$20s to \$30 per

acre. Field areas afflicted by iron chlorosis tend to be spotty. This can sync with the use of precision agriculture tools to help ensure the right acres are treated.

“Variable rate maps that show these areas are hugely beneficial,” says Carlsen. “They’re a way to better manage product placement and help growers maximize their results.”

Putting It All Together

Gleaning 80-bushels-per-acre soybean yields is great, but there’s a price to be paid the following year. “Pulling off yields like that will impact nutrients, especially potassium,” says Tammy Ott, a Nebraska-based Channel technical agronomist. “That’s a big one that needs to be managed as we take off these big soybean yields.”

“Whether broadcast or in-furrow, fertility is an investment,” adds Carlsen. “You’re building a nest egg for future crop production.”

Each soybean management component adds up, says Mark Storr, a BASF technical services representative.

“Just one three-bean pod on every soybean plant can mean an extra 3 bushels per acre,” Storr says. “Whether it’s a seed treatment or a weed-free field, or a fungicide, you can get more of those three-bean pods on plants through those practices.” **SF**



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CENTURY-OLD BARN BECOMES A CANVAS

Mural painter Pamela Kellough gave Terry and Billie Spradlin's beloved Ohio barn a patriotic makeover.

By **Lisa Foust Prater**
Family & Farmstead Editor

Pablo Picasso once said, "The purpose of art is washing the dust of daily life off of our souls." When the art is situated alongside a gravel road, it certainly provides a bright spot in the daily lives of those who are lucky enough to witness it.

Terry and Billie Spradlin bought a former dairy farm near Ray, Ohio, 14 years ago, and immediately fell in love with the century-old barn on the property. It was in rough shape, but rather than tear it down, they decided to fix it. "We knew we had to bring the barn back to life," Billie says.

Once boards were replaced and the structure was stabilized, they decided to take their barn to the next level by having

it turned into a work of art. After seeing a mural painted by artist Pamela Kellough of Chillicothe, Ohio, the Spradlins commissioned her to transform one side of their beloved barn into a mural with an American theme.

Kellough met with the Spradlins, discussed ideas, and got to work. Luckily, the 8×64-foot barn wall was made of newly replaced boards, so she had a good surface to start with. While this was a big project, it wasn't quite as big as her largest, which measured 15×120 feet. Work on the Spradlin barn took five days in July 2020.

Humble Beginnings

Anyone who sees Kellough's murals would assume she has had formal art training, but that is not the case. "I did not have the

privilege of an education in art as no high school art classes were offered," she says. "My last art class was in sixth grade by a really grumpy teacher."

Her creativity could not be stifled, however, and she found outlets in crafting, painting, sewing, and making furniture. "I have a creative monster living inside of me that needs to be fed daily," she says.

She got her start painting murals when a friend who knew she did some painting for crafts asked her to paint her nursery walls. "I was reluctant since I had no training," Kellough says, "but she insisted, I completed the room of baby angels, and it looked wonderful."

This project gave Kellough the confidence to approach builders from the Parade of Homes in Columbus, Ohio. "I participated several years and it catapulted me to another level doing work mostly in the Columbus area," she says. More and more businesses began hiring her, and although she still does some murals in private homes, most of her work is for commercial clients today.

Because she paints in public spaces, she gets a lot of questions from passersby. ▶

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“I will have children ask me, ‘How did you get so good?’ My response is to practice daily, just like you would on a piano,” Kellough says. “Young women will say, ‘I wish I could do what you do,’ and I respond by saying that at their age I couldn’t do what I do. Everything takes time and application of your craft.”

Mural Gone Viral

Before her work on the Spradlins’ barn, Kellough kept busy painting murals across Ohio, posting photos of projects throughout the process on her Facebook page, Pamela Kellough Murals. When a photo of the completed barn mural went viral with around 100,000 shares, she began receiving requests for project sketches and bids from coast to coast.

“I do admit that when my Facebook post was so well received it made me very happy,” Kellough says. “The comments were all so complimentary and kind. Most artists have some insecurity about their work, and when it is well received it is such an affirmation. It reinforces that we are on the right career path.”

Just for Us

Most murals are painted in public spaces or on private property that is visible to the rest of the world, but the Spradlins’ barn isn’t on a busy highway. It can’t be seen from the interstate. It can be viewed only when traveling from one direction on their rural gravel road.

So why did they invest in such a large piece of art when so few people will see it in person? “We didn’t do this for the world. This is just for us,” Billie says. “We love our barn, we love America, and seeing this beautiful mural every day is a reminder of how lucky we are to live where we do.” 

Learn More

Pamela Kellough Murals

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Artist Pamela Kellough stands with the eagle portion of the patriotic mural she painted on a century-old barn in rural Ohio.



When We Were Young

The world is in a hurry to put 2020 behind us, but take a moment to reflect on all that has happened as you look ahead to 2021.

New Year’s Eve and the weeks on either side of it are generally a time of reflection on the year that was and planning for the year ahead.

There’s often a sense of melancholy over how quickly time passes, especially for parents who don’t want their children to grow up too fast, or for those who see more gray hair in the mirror than they did the January prior. “Auld Lang Syne” is a sad song; that’s not a coincidence.

Still, the changing of the calendar brings gratitude for the good things that happened (yes, good things happened) and hope that a better year lies ahead. It’s a time of soul-searching to be sure.

This time, though, it feels different. New Year’s Day 2020 seems like a lifetime ago. We were all so young then, with our parties and our uncovered faces. We had no idea what was about to happen. Thinking about that time now is like watching a movie when you know something awful is coming, but the characters have no clue.

This pandemic has been exhausting. Some of you may have lost loved ones, battled illness yourselves, or faced

financial difficulty. All of us have missed special times with family and friends. Our kids missed milestones. None of us are the same as we were a year ago. Not one of us.

While simply forgetting 2020 is tempting, it’s important that we remember. If you haven’t already written down

your experiences and thoughts about the past year, I encourage you to do so. Future generations need to be told about this. They need to know about the fear, the sadness, and the hardships.

They also need to know about neighbors helping each other and families drawing nearer than ever before, even when physically distant.

Speaking of writing, I would normally be filling out my planner and making tons of resolutions right now, but that feels like an exercise in futility when so much is up in the air. Still, we must find a way to move forward. We have to try.

My plan for 2021 is simple: survive. I’m giving up the usual big goals and focusing on what 2020 has taught me is so important: family, friends, and faith. What else is there?

As you look back and look ahead, I wish you peace, health, and happiness in 2021. 



Lisa Foust Prater



Slow Cooker Herb and Garlic Bread

Dip this hearty bread in your favorite soup.

- 1¼ cups warm water (105°F. to 115°F.)
- 1 tablespoon active dry yeast
- 1 teaspoon sugar
- ¼ cup warm milk (105°F. to 115°F.)
- 2 cloves garlic, minced
- ½ cup plain yogurt (room temperature)
- 1 tablespoon snipped fresh thyme, basil, or rosemary
- 2½ teaspoons salt
- ¾ cups all-purpose flour
- ¼ cup whole wheat flour
- Nonstick cooking spray
- 1 tablespoon yellow cornmeal

1 In an extra-large bowl stir together the warm water, yeast, and sugar; let stand about 10 minutes or until foamy.

2 In a small bowl stir together warm milk and garlic. Stir milk mixture, yogurt, thyme, and salt into yeast mixture. In a medium bowl stir together all-purpose flour and whole wheat flour. Add 2½ cups of the flour mixture to the yeast mixture; stir just until combined. Cover bowl with plastic wrap; let stand at room temperature for 2 hours.

3 Stir 1¼ cups of the remaining flour mixture into dough. Sprinkle a work surface with remaining flour mixture; turn dough onto the floured surface. Knead 2 to 3 minutes. Cover dough; let stand at room temperature for 30 minutes.

4 Lightly coat the inside of a 6-quart slow cooker with cooking spray. Line bottom of cooker with parchment paper; coat paper with cooking spray and sprinkle with cornmeal. Dust top of dough lightly with additional flour; shape dough into a loose ball. Place dough in center of cooker.

5 Cover and cook on high for 2¼ to 2½ hours or until an instant-read thermometer inserted near the center registers 200°F. If possible, turn the crockery liner a half-turn halfway through cooking (do not lift the lid).

6 Preheat broiler. Remove loaf from cooker; peel off parchment paper. Place loaf on ungreased baking sheet. Broil 5 to 6 inches from the heat for 3 to 4 minutes until light brown.

Makes 16 servings. Nutritional information per serving: 126 calories, 1 g fat (0 g sat. fat), 1 mg cholesterol, 26 g carbohydrates, 372 mg sodium, 1 g fiber, 4 g protein.

For recipe questions, email Lisa.FoustPrater@meredith.com. 

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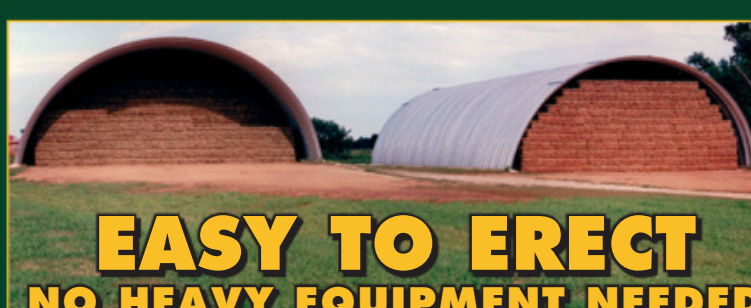
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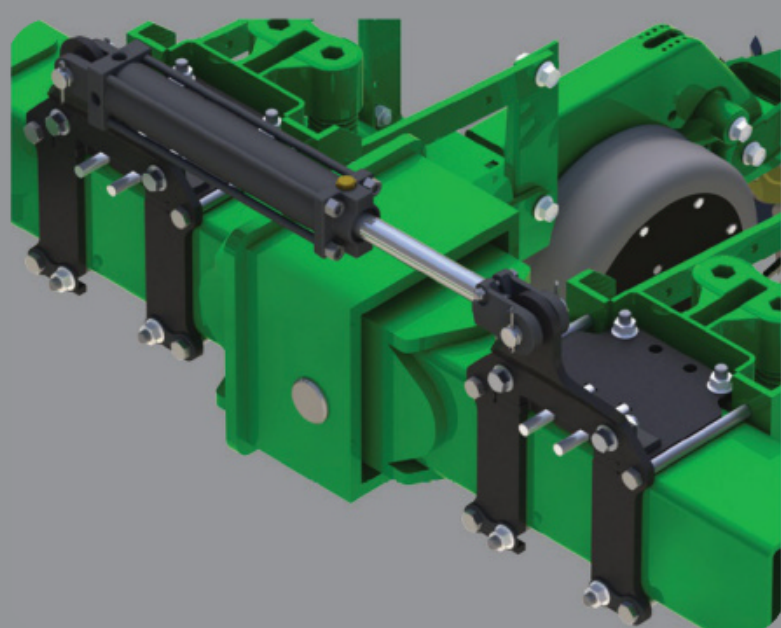
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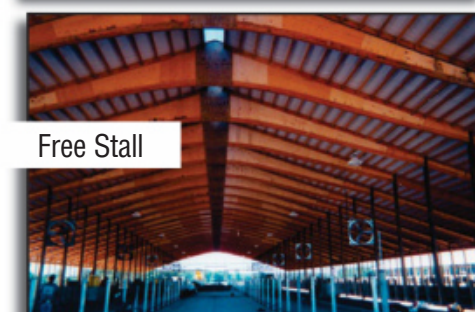
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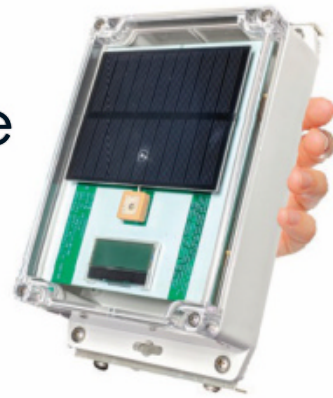
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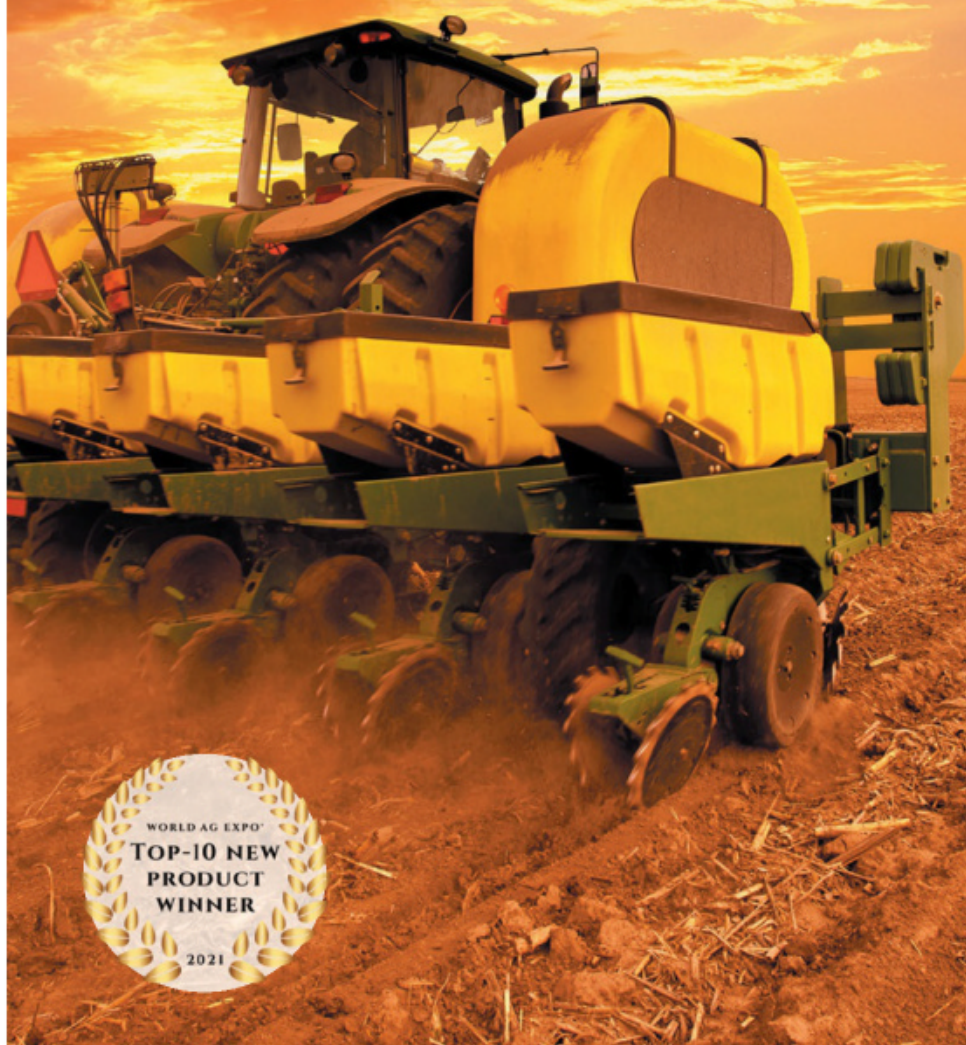
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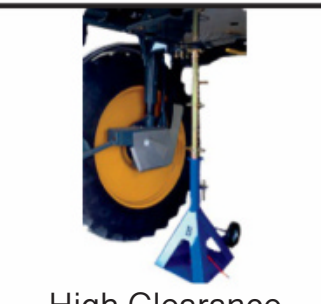
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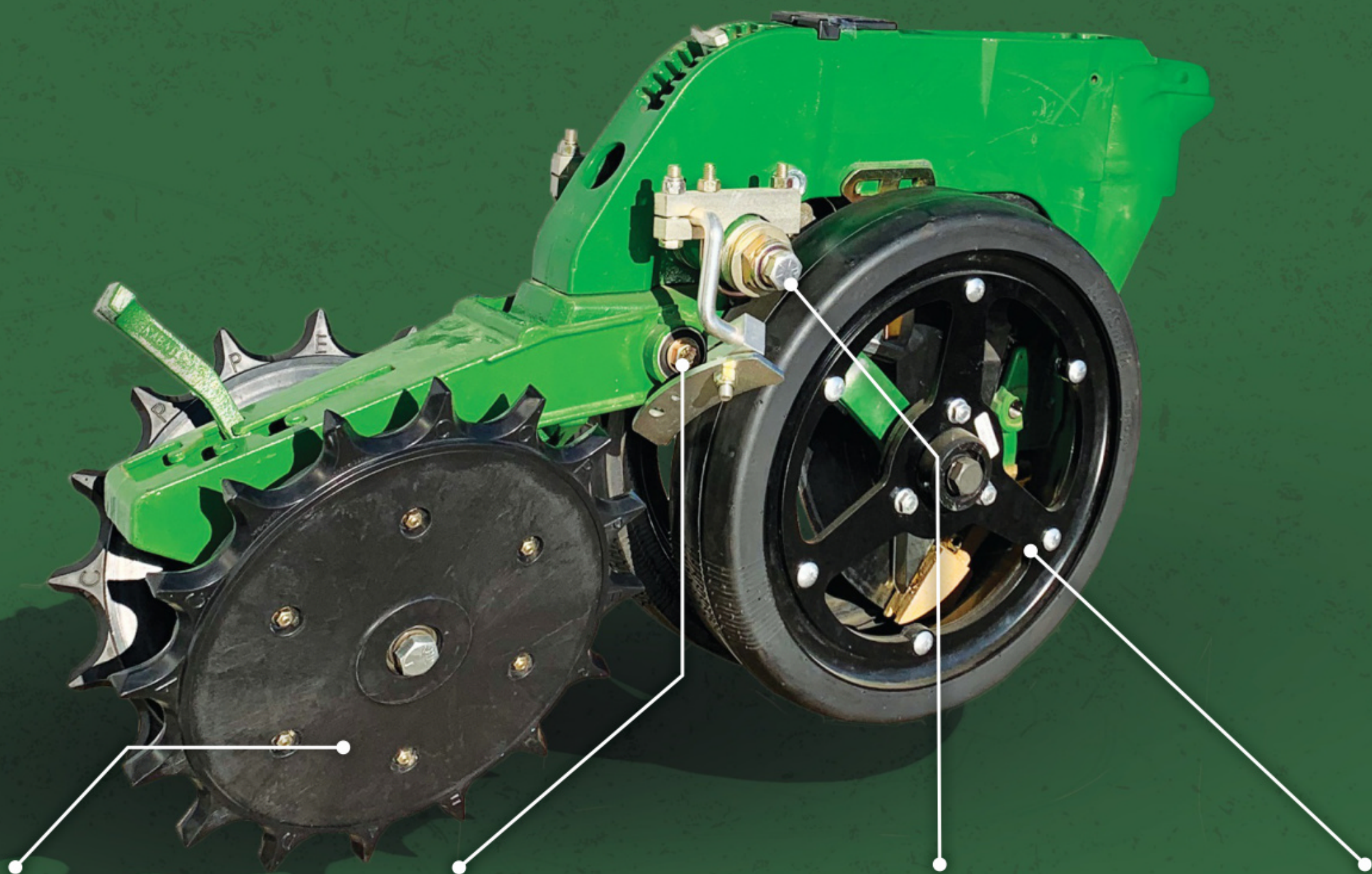
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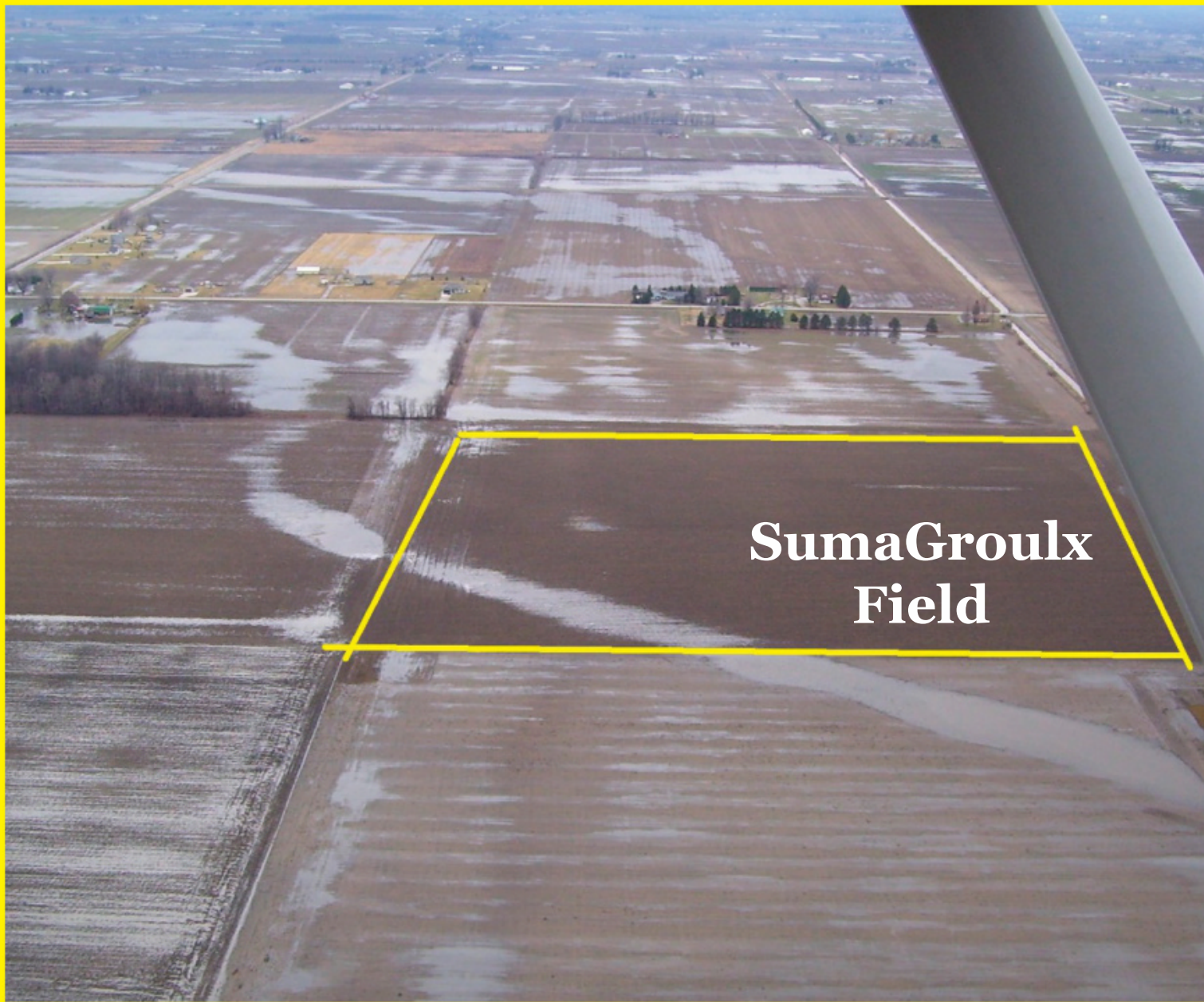
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► Rolling Shop Magnet Keeps Metal Filings Out of Shop Vac

A grinder/mixer magnet is very strong, so it makes a highly effective shop floor sweeper. Swivel wheels on the tray it rests in give it an inch of clearance and movement in all directions. When the magnet is full, just lift by the handle and scrape. I designed this and my friend, Dan Tolan, built it. The magnet is so strong, it kept sucking the steel as he tried to work! We've even seen it take up ¼-inch steel plating.

Roger Johnson
Chandler, Minnesota

◀ Portable DEF Tank For Shop and Fuel Trailer

I repurposed a trolley cart made for bulk oil tanks into one we can use for diesel exhaust fluid (DEF). The reworked cart now has a PVC hose holder and a nozzle holder with a cap to prevent drips. It rolls well on concrete, and we can lift it with forks to go on the fuel trailer during harvest. Right now it has a hand pump, but we're considering an air delivery system.

Duane Wenger
Newton, Kansas
dnwngr85@gmail.com

Same Familiar Bag, Just a Different Way to Open It

Almost everyone cuts across the top of a bag of zip ties to open it. Inevitably, they spill out - and usually at the worst possible time. Try cutting a slot lengthwise down the center instead. When I do this, I'm able to pull them out individually as though from a dispenser.

Paul Sepaniak | Greenwood, Indiana
dmemories1@gmail.com

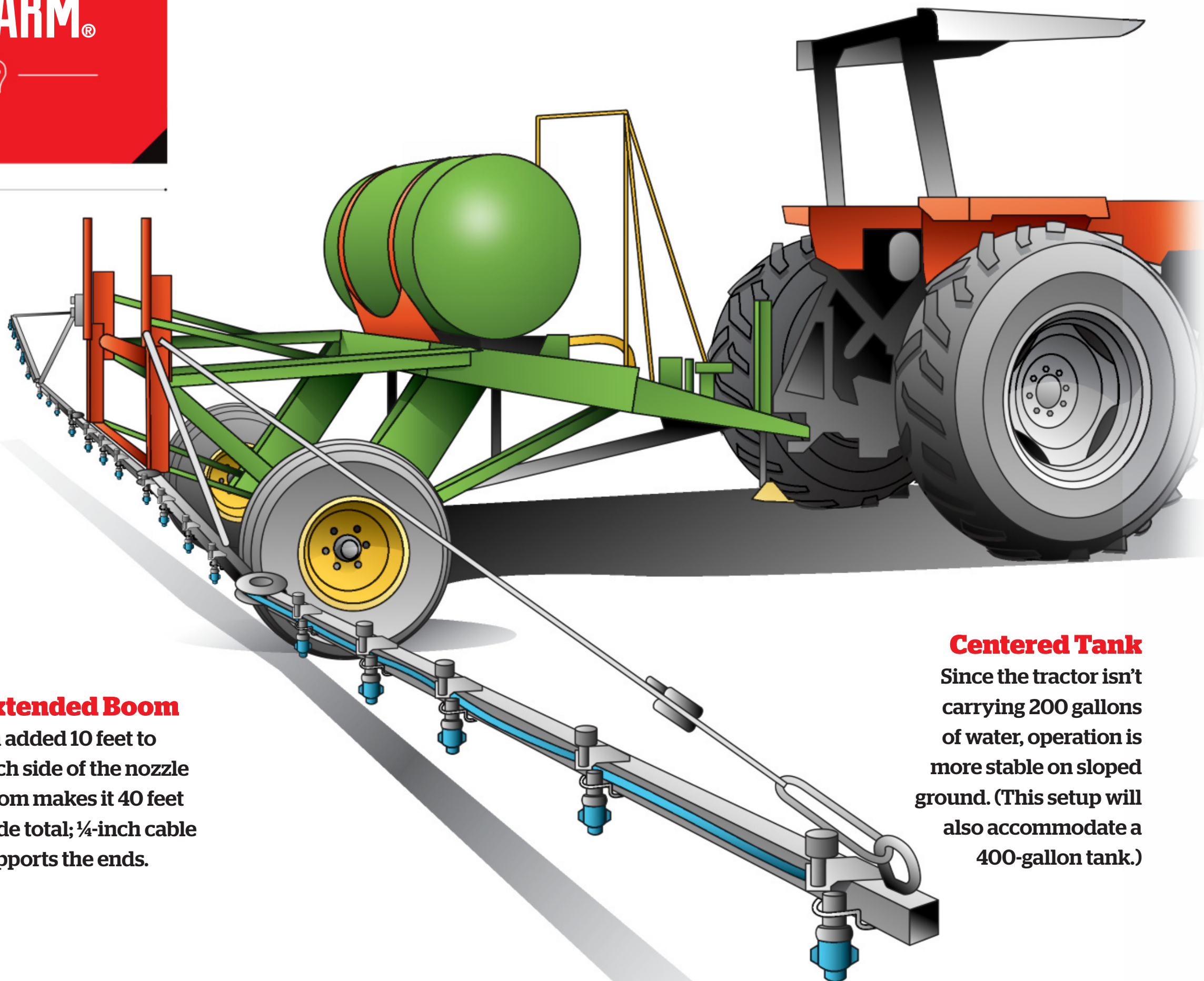
► But How Do You Get Back Out?

A ladder on the outside of a tall truck bed helps if you need to climb up when there is a full load. But what if you need to climb inside the bed when it's empty, and then get out again? I mounted this step made of 1-inch angle steel and ¾-inch rod about 20 inches above the floor. The wire panel allows grain to flow through. Take out three bolts, and the step is easily removed for other kinds of hauling.

Mark Wilsdorf
Madison, Missouri
flagship@mcmsys.com

Send Us Your Ideas

Successful Farming magazine invites you to share ideas with our readers. Submissions should be precise. Include a sketch or photograph when needed. If your idea is used in print, we pay \$400 for the Idea of the Month, \$200 for ideas that appear with drawings, and \$100 for unillustrated ideas. All material submitted becomes the property of Meredith Corporation. If your idea is used, you give Meredith the right to use it in any manner. Enter idea(s), a daytime phone number, email address, and complete mailing address at Agriculture.com/ideaentry or mail to *Successful Farming* Magazine, All Around The Farm, 1716 Locust Street/LS257, Des Moines, IA 50309-3023.



Extended Boom

An added 10 feet to each side of the nozzle boom makes it 40 feet wide total; ¼-inch cable supports the ends.

Centered Tank

Since the tractor isn't carrying 200 gallons of water, operation is more stable on sloped ground. (This setup will also accommodate a 400-gallon tank.)

ROUND BALER TURNED SPRAYER

Idea of the Month: Rig is easier to hook up than a three-point hitch and safer on hilly terrain.

By Paula Barbour, Content Editor

After a fire took Larry Williams' round baler, he reused the frame and upgraded his spraying equipment.

In meshing the two, he was able to reuse his tank, belt, and cradle. Then he built a frame for the tank plus steps and a handrail.

His 20-foot boom is now 40 feet wide. Cable running from the end of the boom back to the top of the factory boom assembly makes each side adjustable. It folds for transport

to the same width as the tires.

Williams put a ball valve in the cab for quick open and close controls. Two hoses on the front of the sprayer have quick-connects.

He installed a quick-connect air chuck for blowing compressed air through the lines. "This makes it easy to winterize," he says.

This winter Williams is plumbing a water supply at the top of the platform for rinsing jugs. Filling the tank from the bottom eliminates foaming. He'll also return to the hand jack instead of the hydraulic cylinder he originally installed. **SF**

Larry Williams

Texan: Son Justin, USAF veteran, will be the sixth generation on the Williams' Beckville farm. They grow hay for feed stores and equine customers in east Texas. Also helping on the farm is wife Pam, who rakes the hay. **Family:** The couple has four grown children. "My beautiful wife is on a championship clogging team, and we've traveled all over the country for her competitions," says Williams.



Speaking of spray: "I cover more acres with the same amount of spray since I started using GPS guidance," he says.

Email: liwilliams81@gmail.com

◀ More ideas from readers on page 71.

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